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CALTRANS LAKE TAHOE STORM WATER SMALL-SCALE PILOT TREATMENT PROJECT

PHASE II REPORT

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Chapter 1 Executive Summary

The State of California Department of Transportation (Caltrans) is conducting the Lake Tahoe Small-Scale Storm Water Treatment Pilot Project to identify and evaluate storm water treatment technologies that may be capable of meeting the Tahoe Basin numeric surface water discharge limits for turbidity, total phosphorus, total nitrogen, total iron, and oil/grease. The project is being carried out at a small-scale pilot treatment facility constructed by Caltrans at its South Lake Tahoe Maintenance Station. Presented in this report are the results and analyses from the second year (Phase II) of the pilot testing program. For a description of the results of the first year investigations, the reader is referred to the "Caltrans Lake Tahoe Storm Water Small-Scale Pilot Treatment Project, First Year Report" (Caltrans Document No. CTSW -RT- 03-042).

1.1 Phase II Facilities and Operations

Phase II of the pilot project included variations of the mechanized (referred to as “high technology” in Phase I) and non-mechanized (“low technology” in Phase I) treatment technologies evaluated during Phase I. Mechanized systems require electrical power, mechanical equipment and skilled operators. Non-mechanized systems are basins and filters that can retain and treat storm water runoff without power (except perhaps for chemical feed systems) or on-site personnel.

Non-mechanized systems tested in Phase II included sedimentation, chemical-assisted sedimentation, and filtration using various granular media. Chitosan (a naturally occurring bio-polymer) and PASS-C® (a polyaluminum chloride coagulant used in drinking water treatment) were used in the chemical-assisted treatment units. Five different granular filter media were selected for testing in Phase II, based on results from Phase I and a survey of the literature. These included fine sand, expanded shale, limestone, wollastonite (a calcium-silica mineral), and activated alumina. The different sedimentation and fine sand filter arrangements tested included 2- and 24-hour sedimentation times, submerged and free-draining filter media, and "slow" and "fast" filter loading rates. Altogether, 15 non-mechanized systems were evaluated.

Two mechanized treatment trains were investigated -- one using proprietary equipment and one using non-proprietary equipment. The proprietary system included an Actiflo® high-rate clarification process, followed by a Fuzzy Filter® (synthetic media filter) and ion exchange columns. The non-proprietary system included a conventional coagulation, flocculation and sedimentation process, followed by a pressure sand filter and ion exchange columns. The coagulation, flocculation and sedimentation processes in both systems were operated in batch mode, while the filters and ion exchange units were operated in a flow-through mode.

During the Phase II test program, storm water runoff was collected from several locations around the Tahoe Basins and trucked to the test facility. Most of the treatment systems were tested using water from six different storm or snow melt events. The wollastonite filter and the chitosan chemical addition were tested for two and three events respectively.

1.2 Summary of Findings

Project results for the second year of pilot plant operation are summarized below, with an emphasis on the ability to comply with the applicable limits for infiltration and surface discharge within the Tahoe Basin. The influent storm water collected within the Tahoe Basin and used for Phase II frequently met many of the less stringent infiltration standards even with no treatment. Consequently, the effluents from many of the treatment systems also met most of these standards. Influents rarely met the surface water discharge standards.

1.2.1 Non-Mechanized Systems

Sedimentation alone, without a chemical to assist in coagulation, almost always failed to meet surface water discharge limits for all constituents, except oil and grease. Increasing sedimentation times from 2 to 24 hours had a small positive effect on the removal of turbidity, phosphorus, and oil and grease.

Chemicals to assist in coagulation significantly improved sedimentation performance. When liquid chitosan was dosed at the optimal level, discharge limits for all regulated parameters were met in all the experimental runs. When PASS-C® was used, surface water discharge limits for some parameters were met in most of the runs. Based on these results, chemical treatment followed by sedimentation alone may be sufficient to meet the surface water discharge limits in some situations. This is, however, only a preliminary conclusion because of the limited number of tests, especially using chitosan. Substantial logistical problems associated with chemical treatment in the field must be addressed also.

Fine sand filters operated under low hydraulic loading (i.e., "slow" filtration rates) performed better than the filters in Phase I, which were loaded as high as the hydraulic conductivity of the media would allow. Reducing the loading rate increased removal of turbidity, total phosphorus, total nitrogen, and total iron. Submerged media conditions resulted in better turbidity and iron removal than filters with free-draining media. Nevertheless, sedimentation without chemicals followed by fine sand filtration, even with a 24-hour sedimentation time and using “slow” loading, submerged media, almost never met surface water discharge limits (except for oil and grease). The oil and grease standard was met most of the time with this treatment system, but the influent met the oil and grease standard in half of the experimental runs. When PASS-C® and 2-hour sedimentation were used upstream of fine sand filtration, the surface water discharge limits for all parameters were met in all of the experimental runs. A “side effect” of using PASS-C® is lowering of the effluent pH, sometimes near or below the minimum value of 6.5 specified for surface waters in the Lahontan Basin Plan.

Filtration through activated alumina following 24-hour sedimentation without chemicals almost always met the surface water discharge limits for all parameters. Turbidity and iron limits were each exceeded once. However, the activated alumina filter increased the pH slightly and contributed dissolved aluminum to the effluent, which may be a toxicity issue.

Filtration through expanded shale following 24-hour sedimentation without chemicals also almost always met the surface water discharge limits for all parameters. Total phosphorus and oil and grease limits were each exceeded once. The shale media, however, increased the pH,

alkalinity, total dissolved solids, and dissolved and acid soluble aluminum concentrations in the effluent. The pH increase was substantial, far exceeding the maximum value of 8.5 specified for surface waters in the Lahontan Basin Plan.

Filtration through limestone media following 24-hour sedimentation without chemicals met the surface water discharge limits for turbidity, phosphorus, and iron in four of six runs. The nitrogen standard was met in five runs and the oil and grease standard was met in all runs. Limestone also resulted in elevated pH, but not to the extent of expanded shale.

Because of logistical difficulties, the wollastonite media was tested only twice in Phase II. Filtration following 24-hour sedimentation without chemicals failed in both test runs to meet the surface water discharge limits for the regulated constituents, except for nitrogen (one run) and oil and grease (two runs).

1.2.2 Mechanized Systems

Both the proprietary and the non-proprietary mechanized systems met all of the surface water discharge standards in all experimental runs. The standards were met after the initial coagulation/flocculation/sedimentation unit, with minor additional improvements in water quality occurring in the downstream filters and ion exchange units. In all cases, the use of PASS-C® resulted in depressed pH, sometimes near or below the minimum target of 6.5. The proprietary Actiflo® process performed somewhat better than conventional coagulation, flocculation and sedimentation at removing turbidity and total iron. Removal of total phosphorus, total nitrogen, and oil and grease was about the same for both the proprietary and non-proprietary systems.

1.3 Potential Future Testing Activities

Sedimentation and filtration systems that performed well without chemicals (i.e., the activated alumina and expanded shale systems) should be evaluated further. Since the experimental runs in Phase I and Phase II represented less than a year's worth of loading under actual field conditions, the systems should be tested with extended run times to evaluate long-term performance and effective service life of the media. For logistical reasons, smaller columns should be considered with the extended run times.

Because of the success with the chemically enhanced sedimentation processes, further testing is warranted. Passive dosing of solid chemical coagulants and different liquid coagulants should be investigated. Likewise the effects of mixing and settling regimes should be evaluated to determine whether these processes can be optimized.

The effectiveness of mechanized systems in a batch configuration has been demonstrated in both Phase I and Phase II. Further small-scale testing of these systems in this configuration is not recommended. Future testing should be done at a larger scale and with flow-through hydraulics.

Chapter 2
Introduction

Chapter 2 Introduction

The Lake Tahoe Small-Scale Storm Water Treatment Pilot Project was implemented by the State of California Department of Transportation (Caltrans) to evaluate storm water treatment technologies for the treatment of roadway runoff in the Lake Tahoe basin. The pilot project is a multi-year program, and this report covers the second year (Phase II) of pilot operations. The background and purpose of the project, previous reports, and the scope of this report are discussed briefly in this chapter.

2.1 Background and Purpose

Storm water runoff from Caltrans facilities in the Lake Tahoe basin are subject to the numerical discharge limits shown in Table 2-1, which were established in the Tahoe Basin Plan, Lahontan Regional Water Quality Control Board (LRWQCB, 1994). The reader is referred to the first-year report for this pilot project, CTSW-RT-03-042 (Caltrans, 2003,) for further discussion of the regulatory framework affecting Caltrans storm water discharges.

Table 2-1. Numeric Storm Water Runoff Discharge Limits

Constituent	Units	Maximum Effluent Concentration	
		Runoff Discharged to Infiltration Systems	Surface Discharges
Total Nitrogen as N	mg/L	5	0.5
Total Phosphate[(a)] as P	mg/L	1	0.1
Total Iron (Fe)	mg/L	4	0.5
Turbidity	NTU	200	20
Oil and Grease	mg/L	40	2.0

(a) Basin plan specifies that total phosphate is measured as "total phosphorus" (LRWQCB, 1994). Project measurements include both total and dissolved phosphorus (as mg-P/L) and total and dissolved orthophosphate (as mg-P/L).

In 2001, Caltrans constructed a research facility at the existing Caltrans South Lake Tahoe Maintenance Station and implemented a small-scale storm water treatment pilot project. The purpose of pilot project is to evaluate the effectiveness of various storm water treatment methods for producing an effluent that complies with the numeric discharge limitations summarized in Table 2-1. This report presents findings from the second year of applied studies at the facility.

2.2 Previous Work (Phase I)

The first year of the small-scale pilot project (Phase I) was accomplished in two parts. Part A consisted of a laboratory-scale jar testing program for the selection of a chemical coagulant and dose for use in the pilot scale treatment facility (Part B). Part B consisted of construction and operation of a pilot scale treatment facility to test the efficacy of several treatment technologies. Findings from the Phase I work are discussed below.

Phase I included the evaluation of both non-mechanized and mechanized (previously referred to as "low technology and high technology") systems for storm water treatment. The non-mechanized systems included various combinations of sedimentation, with and without chemical assistance, and granular media filtration. Both inert and adsorptive filter media were tested, including fine, coarse and concrete sand; aluminum oxide; activated alumina; and zeolite. Based on evaluation of Phase I data, the non-mechanized filtration systems (with the possible exception of filtration with activated alumina media), when used without prior chemical addition and sedimentation, were ineffective at meeting numerical surface water discharge limits for storm water in the Tahoe Basin. The concrete sand, aluminum oxide, and zeolite media did not appear to offer any treatment advantages above that observed with fine sand filtration. In some runs, the activated alumina filtration media demonstrated effective removal of dissolved phosphorus.

The mechanized systems investigated in Phase I included a proprietary high-rate coagulation/flocculation/ballasted-sedimentation process (Actiflo®), followed by a proprietary high-rate synthetic media filter (Fuzzy Filter®), and ion exchange columns. A conventional pressure sand filter was also tested as an alternative to the Fuzzy Filter®. In general, the mechanized systems were effective in meeting most of the numerical limits for surface water discharge, with most of the treatment occurring in the initial treatment step (Actiflo®).

2.3 Phase II Development

Although in Phase I the non-mechanized sedimentation/filtration systems, in the absence of chemicals, were generally not effective in meeting surface water discharge limits (except for somewhat favorable results seen with activated alumina), further research into these types of systems was desired because such systems require minimal operation and maintenance work. The mechanized system tested in Phase I was generally effective in treating storm water but refinements are desirable. Accordingly, Phase II was developed to investigate the following:

1. Longer Sedimentation Times. Increasing the sedimentation time from 2-hours (used in Phase I) to 24-hours should theoretically remove additional solids and therefore improve non-soluble contaminant removal.

2. Filtration Media. Because of somewhat favorable results in Phase I, activated alumina and fine sand filtration media were selected for further investigation in Phase II. Coarse sand, concrete sand, aluminum oxide and zeolite were found to be ineffective in Phase I and were not included in the Phase II testing program. In an effort to develop a non-mechanized media filter capable of treating storm water to the level required within the Tahoe Basin, a review of the literature was conducted to identify additional potentially applicable filter media. Expanded shale, limestone, and wollastonite (calcium metasilicate) were identified and included for testing in Phase II.

3. Slower Filter Loading Rates. In Phase I, storm water was allowed to flow freely through the 30-inch filter units, limited only by the permeability of the filter media and transfer line losses. It was thought that slowing the filtration rate may improve filter performance. Therefore, in Phase II, the filtration rate of the non-mechanized (30-inch) filter units was controlled at a uniform rate (3 ft of settled storm water in 6 hours) via pumping. This slower loading rate is similar to typical full-scale filter loading rates (12 ft of storm water in a 24 hour period).

4. Filter Hydraulic Condition. To minimize channeling of flow and ensure use of the entire filter media area, an outlet device (see Caltrans, 2003a) was installed on selected filter units to maintain the filter media in a "submerged" state.

5. Passive Chemical Dosing with Chitosan. If it is necessary to use chemicals to assist non-mechanized system performance, it would be advantageous to use a chemical and dosing system without metering pumps and flow meters - so called "passive dosing". In Phase I, the application of a polyacrylimide (PAM) using porous bags ("tea bags") placed in the influent flow line to filters was tested, but was not successful due to the inability to properly control the PAM dose. Chitosan was identified as an alternative chemical that may be more amenable to passive dosing (see Caltrans, 2003a). Therefore, testing of chitosan was included in Phase II, together with continued testing of the liquid polyaluminum chloride (PASS-C®) product that was tested in Phase I.

6. Conventional Coagulation/Flocculation. As mentioned previously, the mechanized systems tested in Phase I included the proprietary Actiflo® and Fuzzy Filter® systems. Because purchase of non-proprietary systems is preferable to purchase of proprietary systems, investigation of non-proprietary systems to accomplish the same treatment was identified as an objective for Phase II. Specifically, it was planned to test a conventional coagulation/flocculation/sedimentation process as an alternative to the proprietary Actiflo® system. Testing of pressure sand filtration as an alternative to filtration using the Fuzzy Filter® would also be continued.

7. Optimization of PASS-C® Dosing. In Phase I, when PASS-C® was used in the non-mechanized and mechanized treatment systems, it was applied at a constant dose of 100 mg/L (neat liquid basis). In Phase II, it was planned to do jar testing before each run to allow optimization of the PASS-C® dose and to determine if there was a correlation between the optimal dose and the influent storm water turbidity.

The configuration and operation of pilot treatment facilities to accomplish the testing program developed for Phase II are discussed in more detail in Chapter 3 and in the Phase II Monitoring and Operations Plan, which is referenced in the following subsection.

2.4 Previous Reports

The Lake Tahoe Small-Scale Storm Water Treatment Pilot Project has generated the following reports and documents:

1. *Lake Tahoe Storm Water Treatment Pilot Project Monitoring and Operations Plan*, CTSW-RT-01-054, dated March 2002.

2. *Lake Tahoe Storm Water Small-Scale Pilot Treatment Project Phase II Monitoring and Operations Plan,* CTSW-RT-03-053.33.41, dated May 2003.

3. *Lake Tahoe Storm Water Treatment Pilot Project Jar Test Results and Summary Report*, CTSW-RT-02-075, dated June 2003.

4. *Lake Tahoe Storm Water Small-Scale Pilot Treatment Project First Year Report*, CTSW-RT-03-042, dated August 2003.

The *Lake Tahoe Storm Water Treatment Pilot Project Phase II Monitoring and Operations Plan* (hereinafter referred to as the Monitoring and Operations Plan), dated May 2003, includes detailed descriptions of pilot plant construction, operation, monitoring and sampling for Phase II. Some of the treatment units did not change from Phase I to Phase II. The Phase I Monitoring and Operations Plan includes complete descriptions of the pilot treatment facilities and unit processes tested in Phase I, as well as discussions of pollutant forms, snowmelt dynamics and contaminant removal mechanisms associated with coagulation, flocculation, sedimentation, filtration, and ion exchange. The reader is referred to these two documents for a full description and understanding of plant processes and sampling activities.

2.5 Scope of this Report

Presented in this report are the results of treating six batches of storm water through the pilot treatment systems during the second year of operation (winter/spring 2003). In addition to data presentation, a review of the technologies and recommendations for operational enhancement and potential future pilot studies (Phase III) are presented also.

This report is organized into seven chapters. Chapter 1 contains an Executive Summary. Chapter 2, includes an Introduction and background information for the project. Chapter 3 contains an overview of the Pilot Facilities and Operations, including descriptions of the mechanized and non-mechanized treatment systems, storm water collection procedures, and the sampling and analysis plan. Chapter 4 contains descriptions of the six Phase II experimental runs. Chapter 5 contains Project Results, data analyses, and an assessment of the technologies tested. A summary of findings and recommendations are included in Chapter 6. Appendices to the report include the project data base (Phase II only), miscellaneous data summary tables, filtration media sieve analysis reports, chemistry data quality control summary reports, and MSDS sheets for the chemicals used in the plant treatment units.

Chapter 3

Pilot Facilities and Operations

Chapter 3 Pilot Facilities and Operations

An overview of the second year (Phase II) facilities and operations of the Lake Tahoe Storm Water Small-Scale Pilot Treatment Project is presented in this chapter. Diagrams and tables are presented to indicate how the plant and treatment units were constructed and the position and location of the units within the facility. Significant aspects of sample collection, handling and operations are presented.

3.1 Pilot Facilities

Phase II experimental runs at the Caltrans Storm Water Small-Scale Pilot Treatment facilities (Caltrans South Lake Tahoe Maintenance Station, 2243 Cornelian Drive, South Lake Tahoe, CA) were conducted between March and May 2003. A total of 6 experimental runs representing six runoff events were made. Phase II experiments were designed to evaluate the following treatment processes on storm water contaminant removal:

- sedimentation without chemicals (both 2-hour and 24-hour sedimentation times)
- sedimentation with chemical coagulation/flocculation (two units)
- filtration using various granular filter media preceded by sedimentation (2-hour and 24-hour) without chemical coagulation and flocculation
- filtration using fine sand media preceded by 2 hour sedimentation with chemical coagulation and flocculation
- granular media filtration with submerged and free draining media
- granular media filtration with the filter loaded at a slow rate (3 ft in 6 hours) or loaded rapidly (3 ft in < 30 minutes)
- high-rate, batch, coagulation, flocculation and sedimentation process (proprietary Actiflo®), followed by filtration through a synthetic media filter (proprietary Fuzzy Filter®) and ion exchange (anion and cation)
- conventional batch coagulation, flocculation and sedimentation process (non-proprietary) followed by filtration through a pressure sand filter (non-proprietary) and ion exchange (anion and cation)

To test these treatment processes, eleven “non-mechanized” and two “mechanized” treatment systems were constructed between January and March 2003. Many of the Phase II treatment systems were minor modifications to the existing systems constructed the previous year. A schematic diagram illustrating the layout of the non-mechanized treatment systems is presented in Figure 3-1. A schematic diagram of the two mechanized treatment trains is presented in Figure 3-2. A tabular summary of these treatment systems, including the unit designations, and the process variations is presented in Table 3-1. Descriptions of the critical aspects of each system are presented in the following paragraphs. More detailed descriptions of the pilot treatment processes and facilities can be found in the Monitoring and Operations Plan.

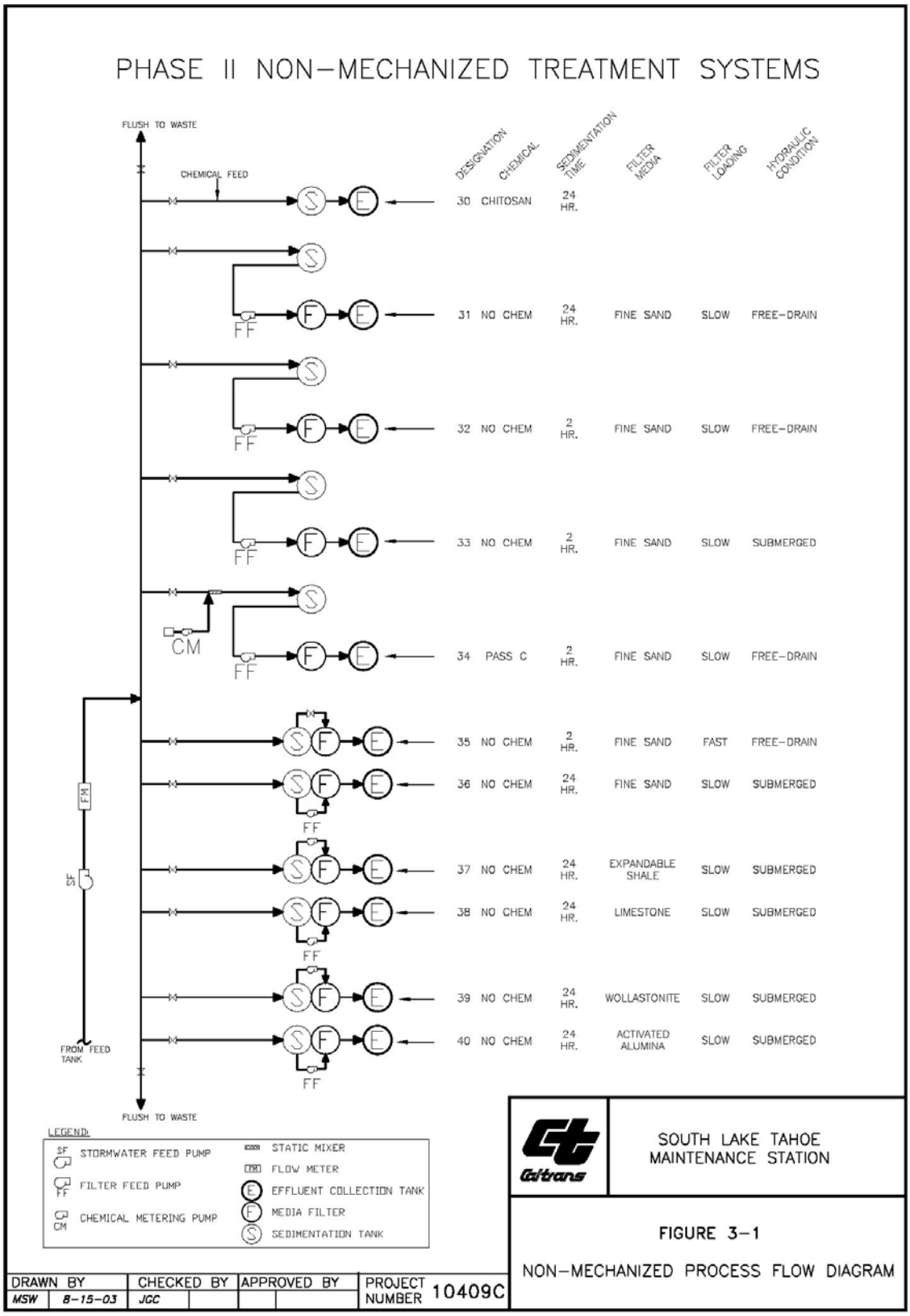


Figure 3-1. Phase II Non-Mechanized Treatment Systems

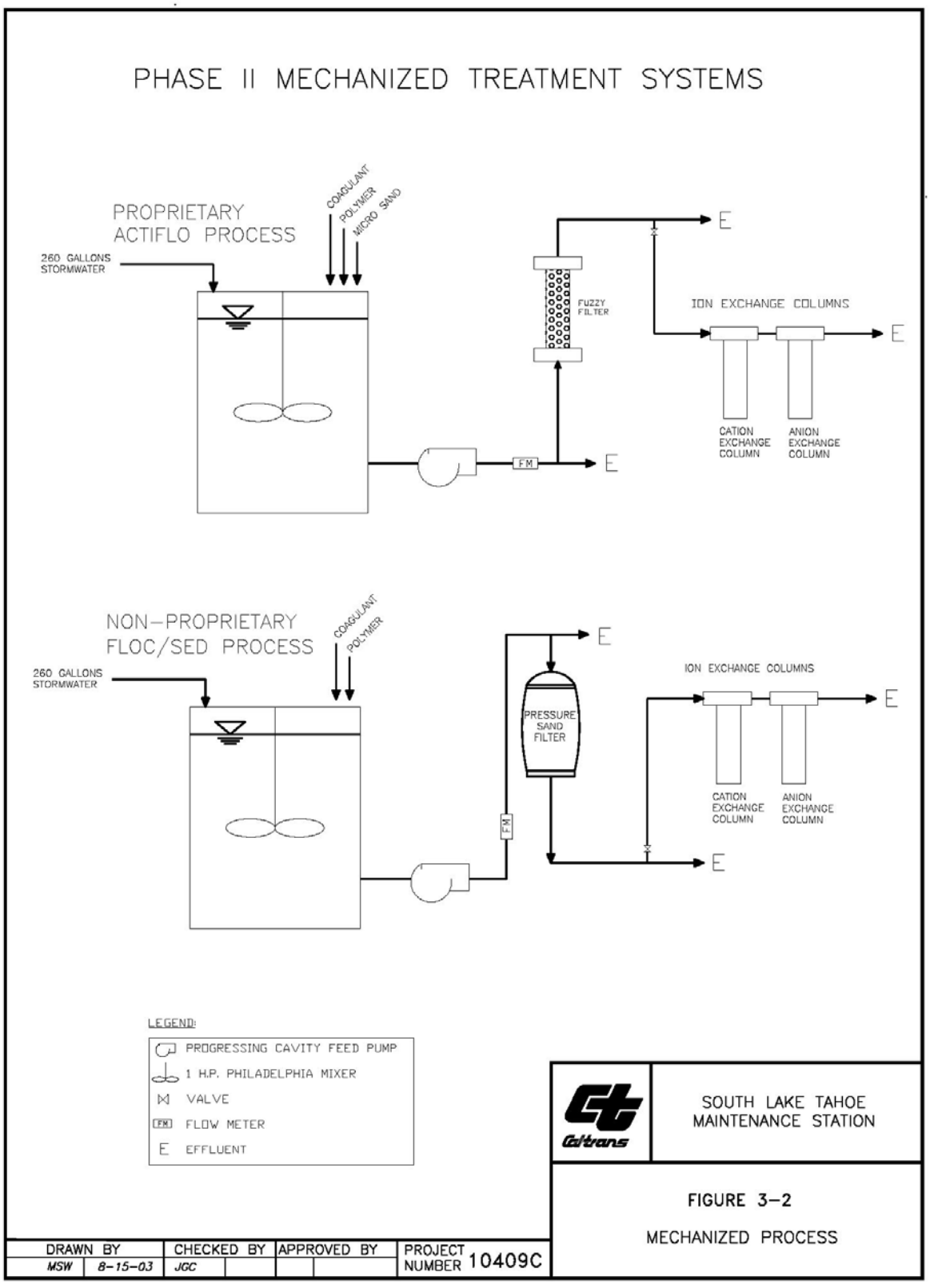


Figure 3-2. Phase II Mechanized Treatment Systems

Table 3-1. Phase II Treatment Systems

Treatment Designation	Sedimentation			Filtration		
	Chemical	Dose	Sed. Time (hrs)	Filter Media	Loading Rate	Hydraulic Condition
NON-MECHANIZED SYSTEMS						
30	Chitosan	Active or Passive	24	None	N/A	N/A
31	None	N/A	24	Fine Sand	Slow	Free-Drain
32	None	N/A	2	Fine Sand	Slow	Free-Drain
33	None	N/A	2	Fine Sand	Slow	Submerged
34	PASS-C®	Variable	2	Fine Sand	Slow	Free-Drain
35	None	N/A	2	Fine Sand	Fast	Free-Drain
36	None	N/A	24	Fine Sand	Slow	Submerged
37	None	N/A	24	Expanded Shale	Slow	Submerged
38	None	N/A	24	Limestone	Slow	Submerged
39	None	N/A	24	Wollastonite	Slow	Submerged
40	None	N/A	24	Activated Alumina	Slow	Submerged
MECHANIZED TREATMENT SYSTEMS						
PA	Proprietary Actiflo®					
PFF	Proprietary Actiflo® + Fuzzy Filter®					
PCA	Proprietary Actiflo® + Fuzzy Filter® + Ion Exchange (cation followed by anion)					
CFS	Conventional Floc/Sed Process					
CPSF	Conventional Floc/Sed Process + Pressure Sand Filter					
CCA	Conventional Floc/Sed Process + Pressure Sand Filter + Ion Exchange (cation followed by anion)					

3.1.1 Filter Media and Conditioning

Ten media filters containing 5 different media were constructed in late February 2003, with the exception of the wollastonite filter, which was installed in March 2003. The filter media investigated were fine sand, activated alumina, limestone, expanded shale and wollastonite. A summary of the media type, vendor and particle size characteristics is presented in Table 3-2. Sieve analysis reports are included in Appendix C.

Table 3-2. Summary of Filter Media Used in Phase II

Filter Media	Product and Vendor	Effective Size[(a)] (D_{10}, in mm)	Uniformity Coefficient[(a)] (D_{60}/D_{10})
Fine Sand	F-105 Filter Sand (0.45-0.55 mm) Loprest Water Treatment Company 2825 Franklin Canyon Road Rodeo, CA, 94572 Tel. (888) 228-5982	0.47	1.5
Activated Alumina	Alcoa DD-2 28 x 48 Schoofs, Inc Los Angeles, CA Tel. (925) 376-7311	0.30	1.6
Limestone	Limestone #4 Sand Teichert Aggregates 3500 American river Drive Sacramento, CA 95864 Tel. (916) 296-4410.	0.15	8.2
Expanded Shale	Utelite Fines (Expanded Shale) Utelite Corporation P.O. Box 387 Coalville, UT, 84017 Tel. (801) 467-2800	0.61	2.5
Wollastonite	Wollastonite Tailings (removed media that passed #50 sieve) Nyco Minerals Willsborough, NY, 12996 Tel. (518) 963-4262	0.38	2.6

(a) Before conditioning

New filter media was placed in each of the 30-inch filter tanks. The media listed in Table 3-2 were conditioned (rinsed) after placement in the filters. Filter conditioning consisted of thoroughly flushing the media with tap water using a 2.4 m (8 feet) section of ¾ in (1.9 cm) PVC pipe connected to a hose. The rinsing pipe was moved up and down through the media bed at various locations, dislodging trapped air, media fines and dirt particles. Conditioning was continued until an effluent turbidly of 2 NTU or less was obtained. Effluent turbidity after filter conditioning is reported in Table 3-3.

Several media required extensive amounts of rinsing because they were not pre-washed media intended for filter use. The limestone and expanded shale (both of which produced black colored effluent), and the activated alumina media (produced milky color rinse water) required extensive rinsing. Of these, limestone required the most rinsing by far. A sample of the limestone media was collected for sieve analysis after conditioning. The post-conditioning sieve analysis showed that the effective size increased from 0.15 to 0.35 mm and the uniformity coefficient decreased from 8.2 to 4.2 (Appendix C).

Table 3-3. Final Filter Effluent Turbidity Values Following Conditioning

Filter	Media	Final Filter Turbidity After Conditioning (NTU)
Rinse Water Used (tap)	-	0.1
31	Fine Sand	0.7
32	Fine Sand	0.8
33	Fine Sand	0.3
34	Fine Sand	0.3
35	Fine Sand	0.2
36	Fine Sand	0.4
37	Expanded Shale	0.8
38	Limestone	0.7
39	Wollastonite	0.9
40	Activated Alumina	1.2

3.1.2 Specific Components – Non-Mechanized Systems

Non-mechanized treatment units included two different unit processes: 1) sedimentation tanks (with and without chemical addition), and 2) granular media filtration (fine sand, expanded shale, limestone, wollastonite or activated alumina). Storm water was pumped into sedimentation tanks (833 L, 220 gallon capacity), allowed to settle and pumped (or released) to a corresponding filter unit. Only the sedimentation tank receiving chitosan (30-S) was not followed by filtration. Filter units consisted of identically sized tanks containing 61 cm (24 inches) of media over a filter fabric, gravel layer and underdrain piping, as described in the Monitoring and Operations Plan. Variations in filter loading, hydraulic condition (filter outlet devices) and chemical feed to the sedimentation tanks are highlighted in subsequent sections.

Sedimentation: All sedimentation tanks received no chemicals, with the exception of two units (chitosan, 30-S and PASS-C®, 34-S). Sedimentation times of 2 or 24 hours were used. PASS-C® was introduced into the storm water using a chemical dosing pump and a static mixer. The dose rate was determined by on-site jar testing. Chitosan was introduced into the storm water by passive "tea bag" or by pumping, as discussed in Section 3.3.1.

Filter Loading: All filters were loaded with settled storm water at a rate of 3 feet in 6 hours, with the exception of Unit #35. After the prescribed settling time was over, a small Masterflex™ pump was engaged to transfer storm water from the sedimentation tank to the filter at a rate of 1,157 mL/min (0.306 gpm). Filter loading for Unit #35 (fast-loading) was accomplished by opening a valve between the sedimentation tank and the filter (fine sand) and allowing the water to flow into the filter at a rate limited only by the hydraulic capacity of the piping and the filter (as in the Phase I studies).

Media Hydraulic Condition: Six of the 10 media filters were fitted with an outlet control device that maintained the media in a submerged condition. This was accomplished by extending the filter outlet piping upward so that discharge occurred at an elevation slightly higher (<1 cm)

than the media surface. Submerging the filter media in this manner allows the water in the filter to be uniformly distributed across the entire filter area and to move at a slow, controlled rate through the media.

Four of the 10 media filters had free draining media. This was accomplished by having the filter underdrain outlet discharge to atmosphere at an elevation below the bottom of the media. In this case, water was distributed to several discrete locations above the media surface and was allowed to drain down through the media, potentially without covering the entire bed area and moving at a velocity governed by the permeability of the portion of the media that was wetted.

3.1.3 Specific Components – Mechanized Systems

The mechanized treatment system facilities used in Phase II were identical to those operated in Phase I, as previously described in the First Year Report (Caltrans, 2003) and the Monitoring and Operations Plan. The first unit process in both of the mechanized treatment trains was the batch coagulation/flocculation/sedimentation process. This process was operated in a proprietary and non-proprietary fashion. After this batch process, the effluent was polished using either a Fuzzy Filter® (proprietary) or a pressure sand filter (non-proprietary). The final unit process in both treatment trains was ion exchange.

Proprietary System: The proprietary high-rate coagulation/flocculation/sedimentation process tested in Phase I and again in Phase II was a batch version of the Actiflo® process, licensed by US Filter, Kruger Products Division. The Actiflo® process uses coagulant, polymer and ballast sand (micro-sand) to clarify waters at a very high rate. For each pilot project run of the proprietary system, a specially fabricated stainless steel tank was filled with 984 L (260 gal) of storm water, chemicals and ballast sand were added and rapidly mixed, and then the tank contents were subjected to a period of gentle mixing (flocculation) followed by a period of quiescent settling. After batch Actiflo® treatment, the effluent was pumped through a proprietary high-rate synthetic media filter (Fuzzy Filter®). Effluent from the Fuzzy Filter® then went through separate anion and cation exchange resin beds. Phase I runs were conducted using a fixed chemical dose (coagulant and polymer) regardless of influent storm water quality. Phase II runs were made using optimized (from on-site jar testing) polymer (Magnafloc® LT25) and coagulant (PASS-C®) doses.

Non-Proprietary System: The non-proprietary coagulation/flocculation/sedimentation process was operated using the same batch tank as the proprietary system. In this case, however, no ballast sand was used and a different mixing/settling time sequence was employed. Effluent from the conventional coagulation/flocculation/sedimentation process was pumped through a pressurized sand filter and separate anion and cation exchange resin beds. The same chemicals and doses were utilized for both the proprietary and non- proprietary equipment runs; however the time required to process the storm water was longer for the non-proprietary equipment runs.

3.2 Operations Summary

Phase II pilot plant operations included storm water collection, storage, treatment, monitoring, and sampling. Project operations were developed to obtain performance data of the highest possible quality. Key operations pertinent to interpretation of the data are briefly presented in the

following sub-sections. Specific details of all operations and monitoring activities can be found in the Monitoring and Operations Plan.

3.2.1 Storm Water Collection Procedures

Storm water was collected for testing as described in Chapter 4. Off-site storm water runoff was collected from detention basins and hauled to the pilot plant in a 3,800-gallon water truck. On-site water was collected from a detention basin within the yard of the Caltrans South Lake Tahoe Maintenance Station. In both cases, the storm water was pumped into and stored in one of two 25,000-liter (6,500 gallon) polyethylene storage tanks (Baker Tanks, Inc) located outside of the pilot treatment building. All storm water collected for testing likely underwent some initial sedimentation in the basin from which it was collected for an undetermined amount of time. Storm water was collected by placing the suction hose of a pump into the basin at a sufficient depth to allow collection, while minimizing the possibility of entraining settled material.

Once filled, the contents of each Baker Tank constituted a single batch of untreated storm water. A submersible mixer in each tank operated continuously to avoid sedimentation and to prevent freezing before and during each run.

3.2.2 Chemical Addition

The chemical coagulant PASS-C® was added to a single non-mechanized treatment unit (34-S) and used in both of the mechanized treatment systems. In all cases, coagulant doses were determined by on-site jar testing. PASS-C® is a liquid polyaluminum chloride (PAC) product made by Eaglebrook® Inc, Matterson, IL. The product formulation is proprietary; however, the manufacturer lists the PAC content between 25 and 40 percent and a product specific gravity of 1.2. A MSDS sheet for PASS-C® is included in Appendix E. To avoid the need to consider the aluminum or other dry solids content of PASS-C, all PASS-C doses used in the pilot project and referenced in this report are based on the mass of neat liquid chemical added. For example, a dose of 100 mg/L of PASS-C means that 100 mg of the PASS-C liquid were added per liter of storm water treated (in contrast, chitosan doses are based on equivalent dry product added).

For the non-mechanized system receiving PASS-C (Unit 34-S), a peristaltic pump was used to introduce the neat liquid into a static mixer in the influent piping to the sedimentation tank. The dose and calibration of the chemical metering pump were verified prior to each batch treatment of storm water. Dedicated feed piping was used for Unit 34-S to ensure that no other units received coagulant.

For the mechanized treatment runs, neat PASS-C® was measured using a graduated cylinder and added directly to the mixing/settling tank. For these systems, a polymer solution (Magnafloc® LT25, a granular anionic polymer made by Ciba Chemicals, Suffolk, VA, see Appendix E) was also used, as described in the Monitoring and Operations Plan.

Chitosan was tested to enhance sedimentation and treatment in Unit #30. Chitosan is a refined natural polymer extracted from chitin, a substance found in the shells of crustaceans such as crabs, shrimp, and lobsters. The chitosan used was provided by Natural Site Solutions, Redmond, WA. A MSDS for chitosan is included in Appendix E. Both solid (Gel-Floc™) and

liquid (Liqui-Floc™) products were used. A passive dosing system (see Monitoring and Operations Plan) was used to introduce solid product in Runs 7 and 8, while a Watson- Marlow™ peristaltic metering pump and static mixer were used to introduce the liquid product in Runs 9 through 12. The target dose rate was 1 mg/L as dry product.

3.2.3 Sampling and Laboratory Analyses

Physical and chemical data were collected during each experimental run for development of design parameters, performance benchmarks, and to assess treatment efficiencies. Monitored water quality parameters are listed in Table 3-4.

Influent Sample Collection. Except samples for oil and grease (O&G), each influent sample was made up of a three-part composite grab sample. Because of the importance of characterizing the influent storm water quality, three different influent samples were collected throughout each run. Two samples were collected during the first day of each run (Day 1) when the non-mechanized units were being filled and one influent sample was collected on the second day of each run (Day 2) when the mechanized systems were being operated. One third of a composite sample was collected during the beginning, middle, and end of each sampling period. The oil and grease sample consisted of two parts, with each part being taken in a separate one-liter sample bottle. The first part of the oil and grease sample was taken at the time of the first composite part for other analyses. The second part of the oil and grease sample was taken at the time of the third composite part for other analyses. The two parts of the oil and grease samples were combined for analysis by the laboratory.

Sedimentation Basins Preceding Slow Load Filters Sample Collection. Sedimentation tank samples, except samples for oil and grease, were collected as two-part composite grabs into a single, five-gallon composite sample bucket. After the sedimentation time was up, one part was collected in the very beginning of the 6-hour filter loading pump cycle. The sample was collected from a sampling port on the side of the sedimentation tank. The sample was collected by opening the valve, flushing a portion to waste, and then filling approximately one-half of the collection bucket (approximately 2 gallons). At the end of the filter loading cycle, the process was repeated, collecting the second half of the two-part composite. The oil and grease samples from the sedimentation basins consisted of two, 1L, grab samples, which were taken at the same time as the two composite parts for the other analytes. The oil and grease grab samples were combined in the laboratory prior to analysis (constituting a single sample).

Table 3-4. Phase II Water Quality Parameters, Reporting Limits and Analytical Methods Used

Field Determinations					
Parameter	**Abbreviation**	**Reporting Limit[c]**	**Units**	**Analytical Method[a]**	
Specific Conductance	EC	1	µmhos/cm	EPA 120.1	
PH	pH	0.1	S.U.[b]	EPA 150.1	
Turbidity	Turb	0.1	NTU	EPA 180.1	
Temperature	Temp	1	°C	EPA 170.1	
Laboratory Determinations					
Parameter	**Abbreviation**	**Required Reporting Limit**	**Units**	**Analytical Method [d]**	**Holding Time**
Alkalinity – Total	Alk-T	1	mg-$CaCO_3$/L	EPA 310.1	14 days
Total Dissolved Solids	TDS	1	mg/L	EPA 160.1	7 days
Total Suspended Solids	TSS	1	mg/L	EPA 160.2	7 days
Nitrate Nitrogen	NO_3-N	0.1	mg-N/L	EPA 300.0	48 hours
Nitrite Nitrogen	NO_2-N	0.1	mg-N/L	EPA 300.0	48 hours
Ammonia Nitrogen	NH_3-N	0.1	mg-N/L	EPA 350.3	28 days
Total Kjeldahl Nitrogen (Filtered)	TKN (F)	0.1	mg-N/L	EPA 351.3	28 days
Total Kjeldahl Nitrogen (Un-Filtered)	TKN (U)	0.1	mg-N/L	EPA 351.3	28 days
Total Phosphorus (Filtered)	Tot-P (F)	0.03	mg-P/L	EPA 365.3	28 days
Total Phosphorus (Un-Filtered)	Tot-P (U)	0.03	mg-P/L	EPA 365.3	28 days
Ortho-Phosphate (Filtered)	O-P (F)	0.03	mg-P/L	EPA 365.2	48 hours
Ortho-Phosphate (Un-Filtered)	O-P (U)	0.03	mg-P/L	EPA 365.2	28 days
Aluminum – Total	Al – T	25	µg/L	EPA 200.8	180 days
Aluminum – Dissolved	Al – D	25	µg/L	EPA 200.8	180 days
Aluminum – Acid Soluble	Al - AS	25	µg/L	EPA 200.8[e]	180 days
Iron – Total	Fe-T	25	µg/L	EPA 200.7	180 days
Iron – Dissolved	Fe-D	25	µg/L	EPA 200.7	180 days
Total Organic Carbon	TOC	1	mg/L	EPA 415.1	28 days
Oil and Grease	O&G	2	mg/L	EPA 1664	28 days

Notes:
[a] To the extent possible, EPA methodology will be followed in the field
[b] S.U. = Standard Units
[c] Refers to instrument resolution
[d] EPA = EPA Methods for Water Analysis
[e] Acid soluble extraction, see EPA 440/5-86-008

Sedimentation Basin Preceding Fast Load Filter Sample Collection. The water quality sample from the rapid load sedimentation tank filter combination (Unit #35) was a two-part composite collected in a single container. One part was collected at the beginning and one part was collected at the end of the filter loading cycle. The filter loading cycle (time for 110 gallons to flow from the sedimentation tank to the filter) typically lasted less than 15 minutes. Oil and grease samples were two-part (two bottles) grab samples taken at the same time as the other composite parts. The two oil and grease parts were then mixed in the laboratory prior to analysis.

Effluent Sample Collection, Non-Mechanized Systems (Filter Effluent). The entire volume of effluent from each non-mechanized treatment system was collected in a dedicated 416 L (110-gal) plastic sample collection barrel. Prior to sampling, water remaining in each submerged filter was pumped out of the filter underdrain and into the collection barrel at the same flow rate as used for the filter loading cycle. Unlike Phase I, each tank was filled only once per run. After completion of the run, the collection tank was sampled by having one person mix the tank with a large paddle while a team (two individuals) took a 15 L (4 gallon) sample into a sample collection bucket. The sample was taken from a valved sample port on the 110-gallon collection barrel, after first flushing the sample port to waste. In a similar fashion, two oil and grease bottles were filled from the sample port.

Mechanized Treatment System Sampling. All sampling of the mechanized treatment systems was accomplished by drawing samples from dedicated, valved sampling ports. A typical mechanized treatment system run lasted about 40 minutes and processed approximately 378 L (100 gal) of storm water. Sampling points included the effluents from the batch mixing/settling tank, Fuzzy Filter®, pressure sand filter, and the final effluent from the ion exchange resin cartridges. Except for oil and grease, a sample consisted of a 2-part composite, with one part collected during the beginning and one part collected at the end of each run. Each composite part consisted of approximately 7.5 L (2.0 gal) collected in a bucket after flushing the sample port at each sample location (both composite parts in the same bucket). As with the other processes, oil and grease samples were two-part (two 1 L sample bottles) grab samples collected during the beginning and end portions of the process run, with the contents of both bottles combined in the laboratory to constitute a single sample.

3.2.4 Sample Processing

Field sample processing activities included splitting the sample into multiple sample containers for various contaminant analyses and filtering various samples for dissolved analyses. Some of the samples required specific container compositions, volumes, and preservatives. These requirements were met in accordance with the sampling and analytical requirements established by Caltrans for the monitoring of storm water and given in *Caltrans Guidance Manual: Storm Water Monitoring Protocols* (Caltrans, 2000). Environmental contamination of the samples during processing was minimized by making use of "clean sampling techniques" (Caltrans, 2000).

3.2.5 Field Measurements of Samples Collected

Sample portions were collected from the composite buckets for field characterization. Temperature, pH, conductivity, and turbidity were measured on-site using portable meters. Operation, calibration and maintenance of these meters were performed according to manufacturer recommendations and as outlined in the Monitoring and Operations Plan.

3.2.6 Sample Identification Numbers

The sample point and numbering designation associated with each treatment unit were presented in Table 3-1. Log numbers used for sample tracking consisted of the run number (7 through 12) followed by the treatment unit designation. A complete list of sample collection points and samples collected is presented in Section 5 (Table 5-1).

3.2.7 Quality Assurance and Control Samples

Quality Control (QC) samples collected throughout the project included field blanks, field duplicates, bottle blanks and laboratory QC samples. Quality control samples were collected and processed like other samples, labeled, recorded on the chain-of-custody forms, and transported to the laboratory along with the rest of the experimental run samples.
A discussion of QC sample results is presented in Section 5.2.1.

3.2.8 Sample Delivery and Chain-of-Custody

Samples were kept on ice from the time of collection until received by the laboratory. Samples shipped to the laboratory were placed inside coolers with ice and were well packaged (i.e. with bubble wrap, foam, etc. when necessary). The coolers were packed with sufficient ice to maintain a temperature near 4°C during transport. Cooler lids were secured with packaging tape. Samples were shipped to the laboratory via commercial delivery service.

3.2.9 Chitosan Application

In an attempt to use a passive dosing system for chitosan, mesh bags containing Gel-Floc™ (solid chitosan) were used in Runs 7 and 8. The bags, after pre-soaking, were suspended in the feed piping to Unit #30. For Run 7, two bags containing approximately 6.4 grams of product (per bag) were placed in the feed piping after 5 minutes of pre-soaking. No floc formation was noted in the sedimentation basin. For Run 8 (2 days later), four bags were deployed after soaking for approximately 90 minutes. Again, no floc formation was noted in the sedimentation basin.

Because it was desired to test the efficacy of chitosan without being impaired by an inadequate dosing system, beginning with Run 9, chitosan was introduced into the feed flow to the #30 sedimentation tank by pumping the liquid chitosan product (Liqui-Floc™) into a static mixer in the feed piping. The approach was to test the chemical effectiveness as part of this study and to leave the potential development of a passive dosing system for future studies.

In Experimental Run 9, the chemical dosing pump was calibrated with water. As a result of the viscosity of the Liqui-Floc™, only a net dose of 0.53 mg/L was obtained. In the subsequent experimental runs, the chitosan feed pump was calibrated using the chemical product. Resulting chitosan doses for Experimental Runs 10, 11, and 12 were 1.1, 0.98, 1.0 mg/L, respectively (target chitosan dose = 1.0 mg/L, dry basis).

3.2.10 Jar Testing

Jar testing was performed as described in the Monitoring and Operations Plan. The optimal coagulant dose was defined as the dose that produced the lowest turbidity in the jar test after 15 minutes of settling. A jar containing a 100 mg/L dose of PASS-C® and the jar with the optimized dose were set aside for 2 hours, after which turbidity was again recorded and a portion of each sample was sent to the laboratory for phosphorus analysis (see Section 5.3.3). In one instance, after settling for 2 hours, the final turbidity was better in the 100 mg/L dose than the "optimized" dose (Run 12).

Following jar testing to determine optimal coagulant dose, a series of jar tests were conducted to determine the optimal polymer (Magnafloc® LT25) dose (holding the coagulant constant at the "optimal" dose). However, the optimal polymer dose was not easily nor precisely determined in many cases. In some tests, a wide range of polymer doses were effective. In other tests, the turbidity readings were erratic and followed no clear trend. Many jar tests were performed several times with the results not always repeatable. This was largely attributed to difficulty in discerning differences between treatments having turbidities less than 5 NTU.

Chapter 4

Pilot Project Experimental Runs

Chapter 4 Pilot Project Experimental Runs

Specific information relating to the six experimental runs (Runs 7–12) conducted during the second year (Phase II) of pilot project operations is presented in this chapter. Additionally, the storm water collected and treated as part of this study is compared to the water quality characteristics reported in the *Tahoe Highway Runoff Characterization and Sand Trap Effectiveness Study* (Caltrans, 2002a).

4.1 Experimental Run Information

Field notes for each of the six experimental runs are summarized in Tables 4-1 through 4-6. Tabulated field notes include the run number, date, water source, weather conditions, influent water quality measurements (pH, EC and turbidity), and the analytical laboratory used. Also included in the tables are specific details and observations relating to the treatment units and their operation and condition.

Table 4-1. Field Notes - Experimental Run # 7

Run Number	7
Date Run	March 16 to 18, 2003
Water Source	Storm water used for Run 7 was collected on 3/15/03 from the basin alongside Highway 89 (4 to 2 lane transition, 0.5 miles south of the South Lake Tahoe city limit) and the Jensen box located at 12th Street and Patricia, South Lake Tahoe. Mix proportion: ¾ Highway 89 basin (approx. 4,875 gallons) ¼ 12th Street Jensen box (1,625 gallons)
Weather	Climate station in South Lake Tahoe recorded 0.02 inches of rain on Friday, March 14th and 0.33 inches in the morning hours of Saturday March 15th.
Storm Water WQ Characteristics	pH = 7.8 (on-site measurements, average of 3 samples) EC = 599 µS Turbidity = 398 NTU Average Temperature = 3.5 °C
Laboratory	ToxScan/Soil Control
Operational Notes and Summary	
Non-Mechanized	New procedures and treatment configuration require the run to be spread out over a three day period. Storm water held and mixed in the outside tank (South) for approximately 31 hours prior to the run.
Run 7	Optimal dose for PASS-C® was determined to be approximately 75 mg/L. Jar test samples were collected for both 100 and 75 mg/L dose and sent to the laboratory for filtered and unfiltered Total-P. Optimal polymer dose was 0.5 mg/L (LT25). Final jar test turbidity was 3.9 NTU for the 100 mg/L PASS-C® dose and 1.9 for the "optimized" dose of 75 mg/L.

Table 4-1. Field Notes - Experimental Run # 7

Unit	Process	Notes/Observations
30-S	Chitosan, 24 hr Sedimentation	Passively dosed chitosan sedimentation tank had a final composite turbidity of 162 NTU. Two "tea bags" containing approximately 6.4 grams were used (pre-soaked for 5 minutes). No floc was observed in the sedimentation tank.
33-S	No-Chemical, 2 hr Sed.	Operated ok
34-S	PASS-C, 2 hr Sedimentation	Operated ok
35-S	No-Chem, 2 hr Sed. for fast load	Operated ok
36-S	No-Chem, 24 hr Sedimentation	Operated ok
38-S	No-Chemical, 24 hr Sed.	Operated ok
31-F	Fine Sand Filter (slow load, free drain) following 24 hr sedimentation	Operated ok
32-F	Fine Sand Filter (slow load, free drain) following 2 hr sedimentation	Operated ok
33-F	Fine Sand Filter (slow load, submer.) following 2 hr sedimentation	Operated ok
34-F	Fine Sand Filter (slow load, free drain) following 2 hr PASS-C sedimentation	Operated ok Produced a final turbidity of 0.5 NTU.
35-F	Fine Sand Filter (fast load, free drain) following 2 hr sedimentation	Operated ok
36-F	Fine Sand Filter (slow load, submer.) following 24 hr sedimentation	Operated ok
37-F	Expanded Shale Filter (slow load, submerged) following 24 hr sed.	Operated ok. Produced a final turbidity of 0.9 NTU, a pH of 11.5 and an EC approximately twice as high as the raw storm water (1296 µS in the shale, 599 µS in the influent).
38-F	Limestone Filter (slow load, submer.) following 24 hr sedimentation	Operated ok
39-F	Wollastonite Filter (slow load, submerged) following 24 hr sedimentation.	No media – unit not run
40-F	Activated Alumina Filter (slow load, submerged) following 24 hr sedimentation.	Operated ok. Unit produced the lowest final turbidity of 0.3 NTU with a pH of 8.8. Activated alumina media decreased the EC from 599 to 382 µS).

Mechanized **Actiflo®**

Proprietary Run

Run 7

Date Run: 3/17/03
Time Run: 14:05 PST
Coagulant Dose (PASS-C, neat): 75 mg/L
Polymer Dose (Magnafloc LT25): 0.5 mg/L
Micro-sand: 5 L

Step	Time (min)	Event or Process	Mixer Speed(HZ)
0	-	Tank filled with 260 gal. storm water	-
1	-	Dose with micro-sand and coagulant	60
2	3.0	Rapid mix	60
3	-	Dose with polymer	60
4	0.5	Rapid mix, continued	60
5	1.5	Maturation, reduce speed	40
6	8	Sedimentation	0

Table 4-1. Field Notes - Experimental Run # 7

Fuzzy Filter®

Flow Rate:	2.6 gpm
Volume Treated:	103 gal
Media Condition:	New

Ion Exchange

Media Condition:	New this Run (however, used for non-mechanized run)
Samples Collected:	IX4 (after IX3)

Notes

Good floc formation and sedimentation noted. The Actiflo® process produced a turbidity of 3.5 NTU. After filtration and ion exchange, effluent turbidity for the proprietary run was 0.2 NTU.

Mechanized

Non-Proprietary Run

Run 7

Conventional Coagulation/Flocculation/Sedimentation

Date Run:	3/17/03
Time Run:	12:37 PST
Coagulant Dose (PASS-C, neat):	75 mg/L
Polymer Dose (Magnafloc LT25):	0.5 mg/L

Step	Time (min)	Event or Process	Mixer Speed (HZ)
0	-	Tank filled with 260 gal. storm water	-
1	-	Dose with coagulant	-
2	0.5	Rapid Mix	60
3	15	Slow mix	6
4	37	Sedimentation	0

Pressure Sand Filter

Flow Rate:	2.6 gpm
Volume Treated:	100 gal
Media Condition:	Unchanged since Run 1

Ion Exchange

Media Condition:	New
Samples Collected:	IX4 (after IX3)

Notes

Good floc that settled well was noted. The conventional batch coagulation/flocculation/sedimentation process produced an effluent turbidity of approximately 7 NTU after 37 minutes of settling. Following ion exchange, the effluent turbidity was approximately 0.5 NTU.

Table 4-2. Field Notes - Experimental Run #8

Run Number	8
Date Run	March 18 to 20, 2003
Water Source	Storm water used for Run 8 was collected on 3/15/03 from the flood control structure located on Ski Run Blvd. (corner of Osgood and Ski Run) in South Lake Tahoe. Sample was collected from the concrete lined forebay structure where the water enters. Contributing area includes streets and roadsides to the south of Lake Tahoe Blvd. All water was collected from this location (6,500 gallons in two trips).
Weather	Climate station in South Lake Tahoe recorded 0.02 inches of rain on Friday, March 14th and 0.33 inches in the morning hours of Saturday March 15th.
Storm Water WQ Characteristics	pH = 7.1 (on-site measurements, average of 3 samples) EC = 243 µS Turbidity = 200 NTU Average Temperature = 5.8 °C
Laboratory	ToxScan/Soil Control

Operational Notes and Summary

Non-Mechanized Run 8

Run 8 storm water was collected on 3/15/03 and used on 3/18/03. A sample was collected from the holding tank on 3/16/03 and sent to the laboratory to determine what changes may have occurred due to extended storage (08-001). Field WQ determinations show no change in turbidity occurred within this holding period (turbidity measured 201 NTU on 3/16/03 and was between 192 and 204 NTUs during the run).

Optimal dose for PASS-C® was determined to be approximately 75 mg/L. Jar test samples were collected for both 100 and 75 mg/L dose and sent to the laboratory for filtered and unfiltered Total-P. Optimal polymer dose was 0.5 mg/L (LT25). Final jar test turbidity was 6.9 NTU for the 100 mg/L PASS-C® dose and 2.9 for the "optimized" dose of 75 mg/L.

Unit	Process	Notes/Observations
30-S	Chitosan, 24 hr Sedimentation	Four "tea bags" containing approx. 6.4 grams/ea. were pre soaked for 90 minutes prior to use. No floc was observed.
33-S	No-Chemical, 2 hr Sed.	Operated ok
34-S	PASS-C, 2 hr Sedimentation	Operated ok
35-S	No-Chem, 2 hr Sed. for fast load	Operated ok
36-S	No-Chem, 24 hr Sedimentation	Operated ok
38-S	No-Chemical, 24 hr Sed.	Operated ok
31-F	Fine Sand Filter (slow load, free drain) following 24 hr sedimentation	Operated ok
32-F	Fine Sand Filter (slow load, free drain) following 2 hr sedimentation	Operated ok
33-F	Fine Sand Filter (slow load, submer.) following 2 hr sedimentation	Operated ok
34-F	Fine Sand Filter (slow load, free drain) following 2 hr PASS-C sedimentation	Operated ok Produced a final turbidity of 0.3 NTU.
35-F	Fine Sand Filter (fast load, free drain) following 2 hr sedimentation	Operated ok
36-F	Fine Sand Filter (slow load, submer.) following 24 hr sedimentation	Operated ok
37-F	Expanded Shale Filter (slow load, submerged) following 24 hr sedimentation.	Operated ok. Produced a final turbidity of 0.9 NTU, a pH of 11.5 and an EC three times as high as the raw storm water (730 µS in the shale, 243 µS in the influent).

Table 4-2. Field Notes - Experimental Run #8

	Unit	Process	Notes/Observations
	38-F	Limestone Filter (slow load, submer.) following 24 hr sedimentation	Operated ok. Produced a final effluent turbidity of 15.8 NTU
	39-F	Wollastonite Filter (slow load, submerged) following 24 hr sedimentation.	No media – unit not run
	40-F	Activated Alumina Filter (slow load, submerged) following 24 hr sedimentation.	Operated ok. Unit produced the lowest final turbidity of 0.1 NTU with a pH of 8.9.

Mechanized

Proprietary Run

Run 8

Actiflo®

Date Run: 3/19/03

Time Run: 10:15 PST

Coagulant Dose (PASS-C, neat): 75 mg/L

Polymer Dose (Magnafloc LT25): 0.5 mg/L

Micro-sand: 5 L

Step	Time (min)	Event or Process	Mixer Speed (HZ)
0	-	Tank filled with 260 gal. storm water	-
1	-	Dose with micro-sand and coagulant	60
2	3.0	Rapid mix	60
3	-	Dose with polymer	60
4	0.5	Rapid mix, continued	60
5	1.5	Maturation, reduce speed	40
6	5	Sedimentation	0

Fuzzy Filter®

Flow Rate: 2.6 gpm

Volume Treated: 127 gal

Media Condition: Same as used in Run 8 (2 days earlier)

Ion Exchange

Media Condition: New

Samples Collected: IX4 (after IX3)

Notes

Good floc formation and sedimentation noted. The Actiflo® process produced a turbidity of 2.6 NTU. Fuzzy filter reduced the turbidity from 2.6 to 0.5 NTU. After filtration and ion exchange, effluent turbidity was 0.3 NTU.

Mechanized

Non-Proprietary Run

Run 8

Conventional Coagulation/Flocculation/Sedimentation

Date Run: 3/17/03

Time Run: 12:37 PST

Coagulant Dose (PASS-C, neat): 75 mg/L

Polymer Dose (Magnafloc LT25): 0.5 mg/L

Step	Time (min)	Event or Process	Mixer Speed (HZ)
0	-	Tank filled with 260 gal. storm water	-
1	-	Dose with coagulant	-
2	0.5	Rapid Mix	60
3	15	Slow mix	6
4	30	Sedimentation	0

Table 4-2. Field Notes - Experimental Run #8

Pressure Sand Filter	
Flow Rate:	2.6 gpm
Volume Treated:	119 gal
Media Condition:	Unchanged since Run 1
Ion Exchange	
Media Condition:	New this run, same as that used in the proprietary run
Samples Collected:	IX4 (after IX3)
Notes	
Good floc that settled well was noted. The conventional batch coagulation/flocculation/sedimentation process produced an effluent turbidity of approximately 7.2 NTU after 30 minutes of settling. Following ion exchange, the effluent turbidity was approximately 0.4 NTU.	

Table 4-3. Field Notes Experimental Run # 9

Run Number	9		
Date Run	May 6 to 8, 2003		
Water Source	Storm water used for Run 9 was collected on May 5 and May 6, 2003 from the basin alongside Highway 89 (4 to 2 lane transition, 0.5 miles south of the South Lake Tahoe City limit), the Jensen box located at 12th Street and Patricia, and the Jensen box located at Al Tahoe Blvd. and Pioneer Trail, South Lake Tahoe, CA. Estimated Mix proportion: 25% from the Highway 89 basin (approx. 1,600 gallons) 29% from the 12th Street Jensen box (approx. 1,900 gallons) 46% from the Pioneer Trail/Al Tahoe Jensen Box (approx 3,000 gallons)		
Weather	Climate station in South Lake Tahoe recorded 0.09 inches of mixed rain and snow starting in the evening of May 3rd and ending in the morning hours of May 4th. Climate station in Meyer's reported 0.7 inches of precipitation for the same period.		
Storm Water WQ Characteristics	pH = 7.0 (on-site measurements, average of 3 samples) EC = 303 µS Turbidity = 62 NTU Average Temperature = 9.5 °C		
Laboratory	ToxScan/Soil Control		
Operational Notes and Summary			
Non-Mechanized	Two loads of storm water were collected 5/5/03 and the third load was collected in the morning of 5/6/03. Therefore, storm water held and mixed in the outside tank (north) for approximately 8 hours prior to the run.		
Run 9	Optimal dose for PASS-C® was determined to be approximately 170 mg/L. Jar test samples were collected for both 100 and 170 mg/L dose and sent to the laboratory for filtered and unfiltered Total-P. Optimal polymer dose was 1.5 mg/L (LT-25). Final jar test turbidity (after 2 hours) was 0.2 NTU for chemical both doses.		
	Unit	**Process**	**Notes/Observations**
	30-S	Chitosan, 24 hr Sedimentation	Liquid chitosan fed into storm water. Chemical feed rate was too low, resulting in a net dose of 0.53 mg/L.
	33-S	No-Chemical, 2 hr Sed.	Operated ok
	34-S	PASS-C, 2 hr Sedimentation	Operated ok
	35-S	No-Chem, 2 hr Sed. for fast load	Operated ok

Table 4-3. Field Notes Experimental Run # 9

	Unit	Process	Notes/Observations
	36-S	No-Chem, 24 hr Sedimentation	Operated ok
	38-S	No-Chemical, 24 hr Sed.	Operated ok
	31-F	Fine Sand Filter (slow load, free drain) following 24 hr sedimentation	Operated ok
	32-F	Fine Sand Filter (slow load, free drain) following 2 hr sedimentation	Operated ok
	33-F	Fine Sand Filter (slow load, submer.) following 2 hr sedimentation	Operated ok
	34-F	Fine Sand Filter (slow load, free drain) following 2 hr PASS-C sedimentation	Operated ok Produced a final turb. of 0.38 NTU.
	35-F	Fine Sand Filter (fast load, free drain) following 2 hr sedimentation	Operated ok
	36-F	Fine Sand Filter (slow load, submer.) following 24 hr sedimentation	Operated ok
	37-F	Expanded Shale Filter (slow load, submerged) following 24 hr sedimentation.	Operated ok. Produced a final eff. turbidity of 1.5 NTU and a pH of 11.2.
	38-F	Limestone Filter (slow load, submer.) following 24 hr sedimentation	Operated ok Final effluent turb of 11.8 NTU
	39-F	Wollastonite Filter (slow load, submerged) following 24 hr sedimentation.	No media – unit not run
	40-F	Activated Alumina Filter (slow load, submerged) following 24 hr sedimentation.	Operated ok. Unit produced the lowest final turbidity of 0.1 NTU.

Mechanized

Proprietary Run

Run 9

Actiflo®

Date Run: 5/07/03

Time Run: 10:10 PST

Coagulant Dose (PASS-C, neat): 170 mg/L

Polymer Dose (Magnafloc LT25): 1.25 mg/L

Micro-sand: 5 L

Step	Time min)	Process	Mixer Speed (HZ)
0	-	Tank filled with 260 gal. storm water	-
1	-	Dose with micro-sand and coagulant	60
2	3.0	Rapid mix	60
3	-	Dose with polymer	60
4	0.5	Rapid mix, continued	60
5	1.5	Maturation, reduce speed	40
6	5	Sedimentation	0

Fuzzy Filter®

Flow Rate: 2.6 gpm

Volume Treated: 128 gal

Media Condition: New (washed and reused)

Ion Exchange

Media Condition: New

Samples Collected: IX4 (after IX3)

Table 4-3. Field Notes Experimental Run # 9

	Notes
	Floc observed to be fine in size and light in color. The Actiflo® process produced a turbidity of 1.9 NTU. Fuzzy filter reduced the turbidity to 0.35 NTU. After filtration and ion exchange, effluent turbidity for the proprietary run was 0.16 NTU.
Mechanized	**Conventional Coagulation/Flocculation/Sedimentation**
	Date Run: 5/07/03
Non-Proprietary Run	Time Run: 13:19 PST
	Coagulant Dose (PASS-C, neat): 170 mg/L
Run 9	Polymer Dose (Magnafloc LT25): 1.25 mg/L

Step	Time (min)	Event or Process	Mixer Speed (HZ)
0	-	Tank filled with 260 gal. storm water	-
1	-	Dose with coagulant	-
2	0.5	Rapid Mix	60
3	15	Slow mix	6
4	30	Sedimentation	0

Pressure Sand Filter	
Flow Rate:	2.6 gpm
Volume Treated:	123 gal
Media Condition:	Unchanged since Run 1
Ion Exchange	
Media Condition:	New this run, same as that used in the proprietary run
Samples Collected:	IX4 (after IX3)
Notes	
Plentiful light colored floc. The conventional batch coagulation/flocculation/sedimentation process produced an effluent turbidity of approximately 0.8 NTU after 30 minutes of settling. Following ion exchange, the effluent turbidity was approximately 0.12 NTU.	

Table 4-4. Field Notes Experimental Run # 10

Run Number	10
Date Run	May 8 to 10, 2003
Water Source	Storm water used for Run 10 was collected on May 6, 2003 from the flood control structure located on Ski Run Blvd. (corner of Osgood and Ski Run) in South Lake Tahoe. Sample was collected from the concrete lined forebay structure where the water enters. Contributing area includes streets and roadsides to the south of Lake Tahoe Blvd. All water used was collected from this location (6,500 gallons in two trips).
Weather	Climate station in South Lake Tahoe recorded 0.09 inches of mixed rain and snow starting in the evening of May 3rd and ending in the morning hours of May 4th. Climate station in Meyer's reported 0.7 inches of precipitation for the same period.
Storm Water WQ Characteristics	pH = 7.9 (on-site measurements, average of 3 samples) EC = 277 µS Turbidity = 15.2 NTU Average Temperature = 8.2 °C
Laboratory	ToxScan/Soil Control

Table 4-4. Field Notes Experimental Run # 10

Operational Notes and Summary

Non-Mechanized

Two loads of storm water were collected on 5/6/03. Storm water held and mixed in the outside tank (south) for approximately 54 hours prior to the run.

Run 10

Optimal dose for PASS-C® was determined to be approximately 200 mg/L. Jar test samples were collected for both 100 and 200 mg/L dose and sent to the laboratory for filtered and unfiltered Total-P. Optimal polymer dose was 1.0 mg/L (LT25) with doses between 0.5 and 1.5 all demonstrating good treatment in the jars. Final jar test turbidity (after 2 hours) was less than 0.2 NTU for chemical both doses.

Unit	Process	Notes/Observations
30-S	Chitosan, 24 hr Sedimentation	Liquid chitosan feed into storm water. Dose measured as 1.1mg/L.
33-S	No-Chemical, 2 hr Sed.	Operated ok
34-S	PASS-C, 2 hr Sedimentation	Operated ok
35-S	No-Chem, 2 hr Sed. for fast load	Operated ok
36-S	No-Chem, 24 hr Sedimentation	Operated ok
38-S	No-Chemical, 24 hr Sed.	Operated ok
31-F	Fine Sand Filter (slow load, free drain) following 24 hr sedimentation	Operated ok
32-F	Fine Sand Filter (slow load, free drain) following 2 hr sedimentation	Operated ok
33-F	Fine Sand Filter (slow load, submer.) following 2 hr sedimentation	Operated ok
34-F	Fine Sand Filter (slow load, free drain) following 2 hr PASS-C sedimentation	Operated ok Produced a final turb. of 0.38 NTU.
35-F	Fine Sand Filter (fast load, free drain) following 2 hr sedimentation	Operated ok
36-F	Fine Sand Filter (slow load, submer.) following 24 hr sedimentation	Operated ok
37-F	Expanded Shale Filter (slow load, submerged) following 24 hr sedimentation.	Operated ok. Produced a final eff. turbidity of 0.4 NTU and a pH of 11.3
38-F	Limestone Filter (slow load, submer.) following 24 hr sedimentation	Operated ok Final effluent turb of 3.5 NTU
39-F	Wollastonite Filter (slow load, submerged) following 24 hr sedimentation.	No media – unit not run
40-F	Activated Alumina Filter (slow load, submerged) following 24 hr sedimentation.	Operated ok. Unit produced the lowest final turbidity of 0.07 NTU

Mechanized

Actiflo®

Proprietary Run

Run 10

Date Run:	5/8/03
Time Run:	12:30 PST
Coagulant Dose (PASS-C, neat):	200 mg/L
Polymer Dose (Magnafloc LT25):	1.0 mg/L
Micro-sand:	5 L

Step	Time (min)	Event or Process	Mixer Speed (HZ)
0	-	Tank filled with 260 gal. storm water	-
1	-	Dose with micro-sand and coagulant	60
2	3.0	Rapid mix	60
3	-	Dose with polymer	60

Table 4-4. Field Notes Experimental Run # 10

	4	0.5	Rapid mix, continued	60
	5	1.5	Maturation, reduce speed	40
	6	8	Sedimentation	0

Fuzzy Filter®

Flow Rate: 2.6 gpm
Volume Treated: 89 gal
Media Condition: New

Ion Exchange

Media Condition: New
Samples Collected: IX4 (after IX3)

Notes

Good floc formation noted but excessive backpressure prevented treatment of 100 gallons. The Actiflo® process produced a turbidity of 0.32 NTU. After filtration and ion exchange, effluent turbidity for the proprietary run was 0.11 NTU.

Mechanized

Conventional Coagulation/Flocculation/Sedimentation

Date Run: 5/08/03
Time Run: 14:50 PST
Coagulant Dose (PASS-C, neat): 200 mg/L
Polymer Dose (Magnafloc LT25): 0.5 mg/L

Non-Proprietary Run

Run 10

Step	Time (min)	Event or Process	Mixer Speed (HZ)
0	-	Tank filled with 260 gal. storm water	-
1	-	Dose with coagulant	-
2	0.5	Rapid Mix	60
3	15	Slow mix	6
4	30	Sedimentation	0

Pressure Sand Filter

Flow Rate: 2.6 gpm
Volume Treated: 119 gal
Media Condition: Unchanged since Run 1

Ion Exchange

Media Condition: New this run, same as that used in the proprietary run
Samples Collected: IX4 (after IX3)

Notes

Polymer dose reduced from 1.0 (optimal dose from jar testing) down to 0.5 because of backpressure problems observed in the proprietary run. The conventional batch coagulation/flocculation/sedimentation process produced an effluent turbidity of approximately 0.21 NTU after 30 minutes of settling. Following ion exchange, the effluent turbidity was approximately 0.09 NTU.

Table 4-5. Field Notes Experimental Run #11

Run Number	11
Date Run	May 20 to 22, 2003
Water Source	Storm water used for Run 11 was collected on May 20, 2003 from the on-site detention basin. The on-site basin was surrounded by snow piled up from yard clearing activities throughout the winter season. Following a warm spell, accumulated water was considered to be representative of snowmelt.
Weather	Prior to sample collection, the climate station in South Lake Tahoe recorded a ten day period of above average high temperatures. Cloud cover was minimal and daily high temperatures were between 59 and 71 °F.
Storm Water WQ Characteristics	pH = 7.4 (on-site measurements, average of 3 samples) EC = 1,417 µS Turbidity = 556 NTU Average Temperature = 11.1°C
Laboratory	ToxScan/Soil Control

Operational Notes and Summary

Non-Mechanized

Storm water from the on-site basin was pumped into the outside storage tank from 2 to 4 pm on 5/20/03. Water was mixed and held for approximately 1 hour prior to the run. It was noted that the basin had completely refilled with snowmelt water by the same time the following day.

Run 11

Optimal dose for PASS-C® was determined to be approximately 100 mg/L. Only the jar test sample for a coagulant dose of 100 mg/L (JA-1) was sent to the laboratory. Optimal polymer dose was 1.0 mg/L (LT-25) with doses between 0.5 and 1.5, all demonstrating good treatment in the jars. Final jar test turbidity for the 100 mg/L dose was 2.8 NTU.

Wollastonite media installed and conditioned prior to the run (5/16/03). Therefore, Units 39-S and 39-F were operated.

Unit	Process	Notes/Observations
30-S	Chitosan, 24 hr Sedimentation	Liquid chitosan feed into storm water. Dose measured as 0.98 mg/L. Large, dark floc observed in sight glass
33-S	No-Chemical, 2 hr Sed.	Operated ok
34-S	PASS-C, 2 hr Sedimentation	Operated ok
35-S	No-Chem, 2 hr Sed. for fast load	Operated ok
36-S	No-Chem, 24 hr Sedimentation	Operated ok
38-S	No-Chemical, 24 hr Sed.	Operated ok
31-F	Fine Sand Filter (slow load, free drain) following 24 hr sedimentation	Operated ok
32-F	Fine Sand Filter (slow load, free drain) following 2 hr sedimentation	Operated ok
33-F	Fine Sand Filter (slow load, submer.) following 2 hr sedimentation	Operated ok
34-F	Fine Sand Filter (slow load, free drain) following 2 hr PASS-C sedimentation	Operated ok Produced a final turb. of 0.19 NTU.
35-F	Fine Sand Filter (fast load, free drain) following 2 hr sedimentation	Operated ok Produced a final turb. Of 339 NTU.
36-F	Fine Sand Filter (slow load, submer.) following 24 hr sedimentation	Operated ok Produced a final turb. of 135 NTU.
37-F	Expanded Shale Filter (slow load, submerged) following 24 hr sedimentation.	Operated ok. Produced a final eff. turbidity of 0.56 NTU and a pH of 11.1

Table 4-5. Field Notes Experimental Run #11

Unit	Process	Notes/Observations
38-F	Limestone Filter (slow load, submer.) following 24 hr sedimentation	Operated ok Final effluent turb of 55.4 NTU
39-F	Wollastonite Filter (slow load, submerged) following 24 hr sedimentation.	Operated ok Final effluent turb of 90.4 NTU
40-F	Activated Alumina Filter (slow load, submerged) following 24 hr sedimentation.	Operated ok. Final effluent turb of 2.6 NTU

Mechanized

Proprietary Run

Run 11

Actiflo®

Date Run: 5/21/03
Time Run: 09:00 PST
Coagulant Dose (PASS-C, neat): 100 mg/L
Polymer Dose (Magnafloc LT25): 1.0 mg/L
Micro-sand: 5 L

Step	Time (min)	Event or Process	Mixer Speed (HZ)
0	-	Tank filled with 260 gal. storm water	-
1	-	Dose with micro-sand and coagulant	60
2	3.0	Rapid mix	60
3	-	Dose with polymer	60
4	0.5	Rapid mix, continued	60
5	1.5	Maturation, reduce speed	40
6	8	Sedimentation	0

Fuzzy Filter®

Flow Rate: 2.6 gpm
Volume Treated: 124 gal
Media Condition: New

Ion Exchange

Media Condition: New
Samples Collected: IX4 (after IX3)

Notes

Large 2mm floc noted. The Actiflo® process produced a turbidity of 1.8 NTU. After filtration and ion exchange, effluent turbidity for the proprietary run was 0.41 NTU.

Mechanized

Non-Proprietary Run

Run 11

Conventional Coagulation/Flocculation/Sedimentation

Date Run: 5/21/03
Time Run: 11:53 PST
Coagulant Dose (PASS-C, neat): 100 mg/L
Polymer Dose (Magnafloc LT25): 1.0 mg/L

Step	Time (min)	Event or Process	Mixer Speed (HZ)
0	-	Tank filled with 260 gal. storm water	-
1	-	Dose with coagulant	-
2	0.5	Rapid Mix	60
3	15	Slow mix	6
4	35	Sedimentation	0

Table 4-5. Field Notes Experimental Run #11

Pressure Sand Filter	
Flow Rate:	2.6 gpm
Volume Treated:	126 gal
Media Condition:	Unchanged since Run 1
Ion Exchange	
Media Condition:	New this run, same as that used in the proprietary run
Samples Collected:	IX4 (after IX3)
Notes	
Large size pale color floc observed. The conventional batch coagulation/flocculation/sedimentation process produced an effluent turbidity of approximately 7.8 NTU after 35 minutes of settling. Following ion exchange, the effluent turbidity was approximately 0.48 NTU.	

Table 4-6. Field Notes Experimental Run #12

Run Number	12		
Date Run	May 27 to 29, 2003		
Water Source	Storm water used for Run 12 was collected on May 27, 2003 from the detention basin in the Caltrans Snow Storage Yard, South Lake Tahoe. At the time of collection, water was running from large piles of snow located at the West end of the yard and entering the pond on the East end.		
Weather	Prior to sample collection, the climate station in South Lake Tahoe recorded approximately two weeks of above average high temperatures. Cloud cover was minimal and daily high temperatures were approaching 80°F.		
Storm Water WQ Characteristics	pH = 7.3 (on-site measurements, average of 3 samples) EC = 259 µS Turbidity = 576 NTU Average Temperature = 14.9°C		
Laboratory	ToxScan/Soil Control		
Operational Notes and Summary			
Non-Mechanized	Storm water from the on-site basin was hauled from the Snow Storage Yard between 8 AM and 1 PM on 5/27/03. Water was mixed and held for approximately 4 hours prior to the run.		
Run 12	Optimal dose for PASS-C® was determined to be approximately 120 mg/L. Jar test samples were collected for both 100 and 120 mg/L dose and sent to the laboratory for filtered and unfiltered Total-P. Optimal polymer dose was 1.5 mg/L (LT-25). Final jar test turbidity values (after 2 hours) were 3.2 and 4.9 NTU (100 mg/L and 120 mg/L, respectively).		
	Unit	**Process**	**Notes/Observations**
	30-S	Chitosan, 24 hr Sedimentation	Liquid chitosan feed into storm water. Dose measured as 1.0 mg/L. Large, dark floc observed in sight glass
	33-S	No-Chemical, 2 hr Sed.	Operated ok
	34-S	PASS-C, 2 hr Sedimentation	Operated ok
	35-S	No-Chem, 2 hr Sed. for fast load	Operated ok
	36-S	No-Chem, 24 hr Sedimentation	Operated ok
	38-S	No-Chemical, 24 hr Sed.	Operated ok

Table 4-6. Field Notes Experimental Run #12

	Unit	Process	Notes/Observations
	31-F	Fine Sand Filter (slow load, free drain) following 24 hr sedimentation	Operated ok
	32-F	Fine Sand Filter (slow load, free drain) following 2 hr sedimentation	Operated ok
	33-F	Fine Sand Filter (slow load, submer.) following 2 hr sedimentation	Operated ok
	34-F	Fine Sand Filter (slow load, free drain) following 2 hr PASS-C sedimentation	Operated ok Produced a final turb. of 0.36 NTU.
	35-F	Fine Sand Filter (fast load, free drain) following 2 hr sedimentation	Operated ok Produced a final turb. of 483 NTU.
	36-F	Fine Sand Filter (slow load, submer.) following 24 hr sedimentation	Operated ok Produced a final turb. of 385 NTU.
	37-F	Expanded Shale Filter (slow load, submerged) following 24 hr sedimentation.	Operated ok. Produced a final eff. turbidity of 2.2 NTU and a pH of 10.9.
	38-F	Limestone Filter (slow load, submer.) following 24 hr sedimentation	Operated ok Final effluent turb of 263 NTU
	39-F	Wollastonite Filter (slow load, submerged) following 24 hr sedimentation.	Operated ok Final effluent turb of 315 NTU
	40-F	Activated Alumina Filter (slow load, submerged) following 24 hr sedimentation.	Operated ok. Final effluent turb of 23.8NTU

Mechanized

Proprietary Run

Run 12

Actiflo®

Date Run: 5/28/03

Time Run: 08:48 PST

Coagulant Dose (PASS-C, neat): 120 mg/L

Polymer Dose (Magnafloc LT25): 1.5 mg/L

Micro-sand: 5 L

Step	Time (min)	Event or Process	Mixer Speed (HZ)
0	-	Tank filled with 260 gal. storm water	-
1	-	Dose with micro-sand and coagulant	60
2	3.0	Rapid mix	60
3	-	Dose with polymer	60
4	0.5	Rapid mix, continued	60
5	1.5	Maturation, reduce speed	40
6	5	Sedimentation	0

Fuzzy Filter®

Flow Rate: 2.6 gpm

Volume Treated: 124 gal

Media Condition: New

Ion Exchange

Media Condition: New

Samples Collected: IX4 (after IX3)

Notes

Typical floc formation noted. The Actiflo® process produced a turbidity of 3.2 NTU. After filtration and ion exchange, effluent turbidity for the proprietary run was 0.90 NTU.

Table 4-6. Field Notes Experimental Run #12

Mechanized	**Conventional Coagulation/Flocculation/Sedimentation**			
	Date Run:	5/21/03		
Non-Proprietary Run	Time Run:	11:25 PST		
	Coagulant Dose (PASS-C, neat):	120 mg/L		
Run 12	Polymer Dose (Magnafloc LT25):	1.5 mg/L		
	Step	**Time (min)**	**Event or Process**	**Mixer Speed (HZ)**
	0	-	Tank filled with 260 gal. storm water	-
	1	-	Dose with coagulant	-
	2	0.5	Rapid Mix	60
	3	15	Slow mix	6
	4	31	Sedimentation	0
	Pressure Sand Filter			
	Flow Rate:	2.6 gpm		
	Volume Treated:	120 gal		
	Media Condition:	Unchanged since Run 1		
	Ion Exchange			
	Media Condition:	New this run, same as that used in the proprietary run		
	Samples Collected:	IX4 (after IX3)		
	Notes			
	Large size pale color floc observed. Water still cloudy after settling. The conventional batch coagulation/flocculation/sedimentation process produced an effluent turbidity of approximately 8.4 NTU after 31 minutes of settling. Following ion exchange, the effluent turbidity was approximately 1.4 NTU.			

4.2 Pilot Project Influent Storm Water

In this section, the locations from which storm water was collected for pilot treatment testing are identified and comparisons of collected storm water quality to "typical" Lake Tahoe Basin storm water quality are made.

4.2.1 Location of Storm Water Collection Sites

Storm water was collected from six different locations as shown in Figure 4-1. Descriptions of the sampling sites are presented in Table 4-7. Most of the collection locations were small man-made basins, specifically intended to capture and detain storm water runoff. A Jensen box is an underground concrete vault with 4 interior baffles (cells) to facilitate sedimentation of storm water. The detention basin located on Ski Run Blvd. is actually the inlet structure to a flood control basin with wetland vegetation for runoff treatment.

Listed in the Field Notes Tables (Table 4-1 through 4-6) are details relating to the storm water used for each experimental run, sampling location, date collected and weather conditions leading to runoff. As indicated in the tables, storm water used for Experimental Runs 7 and 9 was collected from the Jensen boxes and the Highway 89 roadside basin.

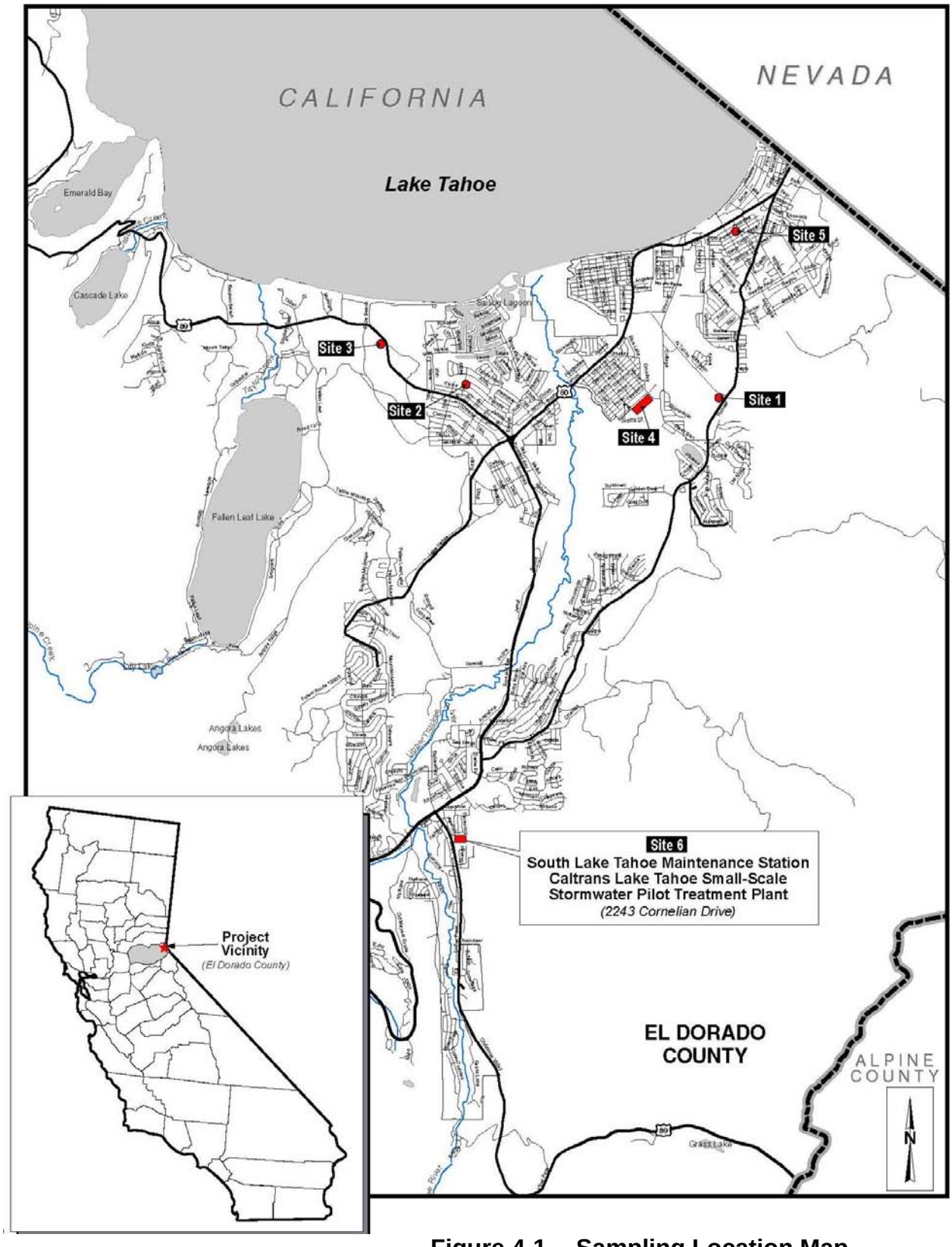


Figure 4-1 Sampling Location Map

Table 4-7. Storm Water Sampling Site Locations

Site Number	Structure	Location Description
1	Jensen Box	Southwest corner on the intersection of Pioneer Trail and Al Tahoe Blvd., South Lake Tahoe, CA. Box is situated approximately 5 feet off the paved bike lane. Runoff contributions from curb and gutter only. Storm water collected from the first cell.
2	Jensen Box	West side of 12th Street at the intersection of Patricia St., South Lake Tahoe, CA. Box is situated alongside a foot trail approximately 10 ft off the roadside. Runoff contributions from curb and gutter only. Storm water collected from the first cell.
3	Detention Basin	West side of Highway 89 (Emerald Bay Road) at the 4 lane to 2 lane transition, just outside of the South Lake Tahoe City limits. Runoff contributions primarily from Highway 89. Storm water runoff collected by lowering a suction line off the bottom and draining most of the basin.
4	Detention Basin/ Pond	Caltrans Snow Storage Yard, located at the end of Sierra Boulevard in South Lake Tahoe, CA. Runoff primarily from melting snow mounded in the yard. Water collected from the first pond, alongside the northwest access road as close to the influent stream as possible.
5	Detention Basin/ Pond	Northeast corner of the intersection of Ski Run Blvd. and Osgood St., South Lake Tahoe, CA. Basin is a concrete lined inlet forebay to a flood control/storm water treatment basin/wetland. Contributions to the basin are primarily from city streets. Water collected at the inlet pipe.
6	Detention Basin	On-site detention basin located on the South Lake Tahoe Maintenance Station (2243 Cornelian Drive, South Lake Tahoe, CA) property, adjacent to the pilot storm water treatment building. Contributions to the basin are from surface water runoff from the maintenance yard and from snow melt. Water collected by lowering a pump suction line (off the basin bottom) and pumping directly up to the pilot plant storage tanks.

Storm water used for experimental Runs 8 and 10 was collected from the inlet to the flood control basin (and wetland) located on Ski Run Blvd., South Lake Tahoe. Storm water used for Experimental Run 11 was collected from the on-site basin at the maintenance station. This was the only storm water that was not trucked to the plant; rather, the storm water was pumped directly from the basin to the outside Baker tank. For experimental Run 12, storm water was collected from the Snow Storage Yard, South Lake Tahoe. The following observations of influent water quality were made:

- Experimental Run 7 (3/15/03) storm water was primarily made up of water collected from the Highway 89 roadside basin with the remainder (1/4) of the tank made up with water collected from the Jensen box (12th and Patricia). Experimental Run 12 storm water was also collected from a basin (situated at the maintenance station). These two sites had the highest levels of EC, TSS, TDS, and aluminum.
- The water collected from the Snow Storage Yard (Run 12) and the on-site basin (Run 11) had the highest levels of total iron, total aluminum, total phosphate and turbidity.
- The storm water collected on May 6, 2003 (Run 10) from the forebay on Ski Run Boulevard was the "cleanest" water used. The water had a turbidity of approximately 15 NTU, TSS of 23 mg/L, total nitrogen of 0.3 mg-N/L, total phosphorus of 0.09 mg-P/L, total iron of 740 µg/L, and no measurable oil and grease (<2 mg/L).

4.2.2 Tahoe Basin and Plant Influent Storm Water Quality

Water quality data for storm water runoff collected as a part of this project as well as "typical" Lake Tahoe Basin storm water quality data are presented in Table 4-8. The "typical" Lake Tahoe Basin storm water quality data are based on samples collected from six different sites during the 2001-2002 season (Caltrans, 2002a). Runoff samples were collected during storm events using automatic, flow-proportional samplers. Minimum, maximum and mean values listed in Table 4-8 (under the heading of Typical Lake Tahoe Basin Storm Water Quality) are the low, high and mean of "event mean concentration" (EMC) values.

Pilot project influent values listed for each run in Table 4-8 are averages of all pilot project influent samples collected, and not EMC values.

Contaminants with regulated numerical limits (i.e., turbidity, oil and grease, total nitrogen, total phosphorus, and total iron) as listed in Table 2-1 are present in Lake Tahoe Basin storm water runoff in concentrations that exceed those limits. Of particular significance to the Winter/Spring 2001/2002 survey:

- Storm water runoff was found to have a mean EMC for turbidity of approximately 531 NTU. The effluent limit for surface water discharge is 20 NTU and the limit for infiltration systems is 200 NTU.
- The mean EMC for oil and grease was 22 mg/L, which is 10 times the limit of 2 mg/L for surface discharge, but below the limit of 40 mg/L for infiltration systems.
- Total nitrogen can be calculated from the sum of NO_3, NO_2, and TKN. Mean EMC total nitrogen was approximately 2.8 mg-N/L. This total nitrogen concentration is approximately 5 times the surface discharge limit of 0.5 mg-N/L, but below the limit of 5 mg-N/L for infiltration systems.
- The mean EMC total iron concentration was 16,884 µg/L (16.9 mg/L), which is over 30 times higher than the 500 µg/L (0.5 mg/L) regulatory limit for surface discharge and over three times the limit of 5,000 µg/L (5 mg/L) for discharge to infiltration systems.
- It is uncertain exactly what form of phosphorus is regulated by the Lahontan Regional Water Quality Board. The Basin Plan lists a numerical storm water discharge limit of 0.1 mg/L of "total Phosphate as P" for surface discharges and a limit of 1 mg/L for discharges to infiltration systems. Additionally, the Basin plan specifies that total phosphate is measured as "total phosphorus" (LRWQCB, 1994). Assuming the intent is to regulate total phosphorus as P, the basin mean EMC for total phosphorus was 0.4 mg/L, four times the regulatory limit of 0.1 mg/L for surface discharge but below the limit for discharge to infiltration systems (1 mg/L).

Table 4-8. Storm Water Runoff Quality for the Tahoe Basin and the Six Experimental Runs

Parameter	Units of Measure	Typical Lake Tahoe Basin Storm Water Quality[a] (EMC)			Pilot Project Influent Quality (Run Average)						
		Min.	Max.	Mean	Mean	Run 7	Run 8	Run 9	Run 10	Run 11	Run 12
pH	pH units	5.9	9.6	7.3	7.2[d]	7.8	6.8	7.0	7.9	7.4	7.3
EC	µmhos/cm	25	21,000	2,735	516	599	242	303	277	1,417	259
TSS	mg/L	36	2,500	761	222	369	175	60.1	22.7	480	227
TDS	mg/L	13	12,000	1,449	306	312	146	159	172	781	268
Hardness	mg/L	4	2,500	120	35	30	28	37	62	24	30
TOC	mg/L	2.6	180	27	12	12	11	13	5.3	15	16
Turbidity	NTU	25	1,500	531	301	397	197	62.2	15.2	556	576
Oil and Grease	mg/L	6	45	22	5[b]	11	5	<2	<2	11	<2
Nitrate-Nitrogen	mg-N/L	0.1	2	0.4	<0.1	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Nitrite-Nitrogen	mg-N/L	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
TKN-T	mg-N/L	0.6	14	2.4	0.88	1.4	0.98	0.72	0.26	0.96	0.97
Total Nitrogen	mg-N/L	0.7	16	2.8	0.89	1.4	0.98	0.72	0.29	0.96	0.97
Phosphorus-T	mg-N/L	0.09	1.5	0.40	0.52	0.62	0.50	0.18	0.09	0.88	0.86
Phosphorus-D	mg-N/L	<0.03	1.1	0.11	0.03[b]	<0.03	0.05	<0.03	0.05	0.06	<0.03
Orthophosphate –T	mg-N/L	0.03	0.6	0.08	0.27[b]	0.41	0.21	0.05	<0.03	0.67	0.24
Aluminum-T	µg/L	*NA*	*NA*	*NA*	9,871	12,000	6,633	1,250	343	18,333	20,667
Aluminum-D	µg/L	*NA*	*NA*	*NA*	<25	27	<25	<25	<25	<25	<25
Aluminum –AS[c]	µg/L	*NA*	*NA*	*NA*	360	459	293	140	<25	710	547
Iron-T	µg/L	1,180	80,700	16,884	10,268	10,667	6,433	2,767	743	20,667	20,333
Iron-D	µg/L	32	4,460	499	40[b]	45	<25	117	39	<25	<25

a Data from Caltrans Tahoe Highway Runoff Characterization and Sand Trap Effectiveness Studies, 2001-02 Monitoring Season, CSTW-RT-02-044.
b Mean of project storm water influent samples (I-01, I-02, I-03, see "I-Avg" in the d-base). Means calculated using ½ of reporting limit value for concentrations below reporting limit.
c Acid soluble aluminum by EPA method 440/5-86-008 (unfiltered sample collected in the field, acidified and filtered in the laboratory).
d Mean for pH calculated by averaging the molar concentration of the hydrogen ions.
NA Not Available (statistics not reported in publication cited); T = Total; D = Dissolved

Based on the data in Table 4-8, the quality of storm water treated as part of this pilot project was generally similar to that reported in the 2001-2002 Tahoe Basin monitoring season report (Caltrans, 2002a). Direct comparisons of the mean values are not appropriate, since the 2001-2002 Monitoring Season Report presents event-mean-concentration values. Storm water hauled and used in the pilot project was typically collected during the first period of significant runoff of a given storm event. Most of the pilot project influent water quality parameters fell within the minimum and maximum EMC values reported in the Tahoe Basin monitoring report; however, most of the pilot project influent parameters were lower in concentration than the mean EMC values. Of particular importance:

- The concentrations of nitrogen compounds in the pilot project influent were appreciably lower than the mean EMC reported in the 2001-2002 Tahoe Basin monitoring report.
- Total phosphorus and ortho-phosphate concentrations were typically higher in the pilot project storm water than the mean EMC reported in the Tahoe Basin monitoring report.
- As observed in Phase I, oil and grease concentrations were lower in the pilot project influent water than the mean EMC reported in the Tahoe Basin monitoring report. The collection of storm water from ponds and vaults was accomplished by lowering the water truck pump suction line into the pool. This procedure may have under- represented oil and grease by missing any floating product. Additionally, oil and grease may have been lost due to transfer (oil and grease can transfer out of the water and stick to water truck hoses, tanks and piping, etc.).
- The concentrations of TDS, TSS, EC, turbidity and iron were lower in the pilot project influent than the mean EMC values reported in the 2001-2002 Tahoe Basin monitoring report.

4.2.3 Evaluation of Day 1 to Day 2 Influent Samples

Operation of the pilot systems required three days for every batch of collected storm water. The majority of the units were filled with storm water the first day. The mechanized systems were typically filled with storm water on the second day. Storm water was held in the outside Baker tanks until used in the plant. Two influent samples were collected on the first day to characterize the water quality being fed to the non-mechanized treatment units. A single influent sample was collected to characterize the influent water quality to the mechanized treatment systems.

Influent water quality from day 1 was compared to day 2 to assess any differences attributable to a longer holding time. A tabular summary of Day 1 and Day 2 influent samples for Runs 7 through 9 and 10 through 12, respectively, is presented in Tables B-1 and B-2 in Appendix B. There is little difference or observable trends in the storm water quality between Day 1 and Day 2.

Chapter 5

Project Results

Chapter 5 Project Results

An assessment of the performance of the various treatment units during the second year (Phase II) of operation is presented in this section. The assessment is based primarily on the ability to remove contaminants from Lake Tahoe Basin storm water to concentrations required by the Lahontan Regional Water Quality Control Board for discharge to ground or surface water. In the paragraphs that follow, data quality and presentation issues are discussed first. Treatment results are then presented sequentially by contaminant. Lastly, an overall assessment is presented for the different technologies.

5.1 Data Quality and Presentation

Included in the following subsections are discussions relating to data presentation and quality. A summary of the quality assurance steps taken to ensure data accuracy and precision and an assessment of the qualified data are also presented. Approximately 4,630 individual water quality data points were collected. Individual treatment unit performance for specific contaminants is shown on "plot pages" included at the end of this chapter. An explanation of how to read the data, format and legends associated with the plot pages is presented at the end of this section.

5.1.1 Data, Sampling Points and Samples Collected

A complete tabulation of the field and laboratory data collected in the second year (Phase II) operation is compiled in Appendix A. Each appendix page contains a data table for a single treatment unit or "sampling point". A list of treatment units, sampling point designations, and what treatment units were sampled during each experimental run is presented in Table 5-1. All units were operated and sampled for all six experimental runs (Runs 7 through 12), except the wollastonite filter, which was operated for Runs 11 and 12 only (sieved wollastonite media arrived on-site too late to be included in the first 4 experimental runs). Included in the database pages (Appendix A) are calculated averages of all three influent samples (I-Avg = average of I-1, I-2, and I-3) and calculated averages of the two 24-hour sedimentation tank samples (24hrSedAvg = average of 36-S and 38-S). Also included in Appendix A are data tables for the jar test samples (JA-1 = fixed 100 mg/L PASS-C® dose and JA-2 = variable dose) and the quality control (QC) samples (log numbers 41 – 44). Additional detail of the log numbers used, units sampled and QC sample types can be found in the Monitoring and Operations Plan.

Table 5-1. Phase II Sample Point Designation, Process Description, and Samples Collected

Sampling Point Designation	Process Description	Sample Collected[a]					
		Run 7	Run 8	Run 9	Run 10	Run 11	Run 12
I-1	Composite, Day 1	X	X	X	X	X	X
I-2	Composite, Day 1 Replicate (See QA Samples, 41-S)	X	X	X	X	X	X
I-3	Composite, Day 2	X	X	X	X	X	X
30-S	Chitosan Passively Dosed, 24 hr. Sed. time (Sed only, 6 hr. slow drain)	X	X	X	X	X	X
31-F	Fine Sand Filter, Slow Loading, Free Drain (No Chem, 24 hr. Sed Time)	X	X	X	X	X	X
32-F	Fine Sand Filter, Slow Loading, Free Drain (No Chem, 2 hr. Sed Time)	X	X	X	X	X	X
33-S	No Chem, 2 hr. Sed Time (Preceding #33-F, Fine Sand Filtration)	X	X	X	X	X	X
33-F	Fine Sand Filter, Slow Loading, Submerged (No Chem, 2 hr. Sed Time)	X	X	X	X	X	X
34-S	Variable PASS C, 2 hr. Sed Time (Preceding #34-F, Fine Sand Filtration)	X	X	X	X	X	X
34-F	Fine Sand Filter, Slow Loading, Free Drain (Pass C, 2 hr. Sed Time)	X	X	X	X	X	X
35-S	No Chem, 2 hr. Sed Time (Preceding #35-F, Fine Sand Filtration)	X	X	X	X	X	X
35-F	Fine Sand Filter, Fast Loading, Free Drain (No Chem, 2 hr. Sed Time)	X	X	X	X	X	X
36-S	No Chem, 24 hr. Sed Time (Preceding #36-F, Fine Sand Filtration)	X	X	X	X	X	X
36-F	Fine Sand Filter, Slow Loading, Submerged (No Chem, 24 hr. Sed Time)	X	X	X	X	X	X
37-F	Shale Filter, Slow Loading, Submerged (No Chem, 24 hr. Sed Time)	X	X	X	X	X	X
38-S	No Chem, 24 hr. Sed Time (Preceding #38-F, Limestone Filtration)	X	X	X	X	X	X
38-F	Limestone Filter, Slow Loading, Submerged (No Chem, 24 hr. Sed Time)	X	X	X	X	X	X
39-F	Wollastonite Filter, Slow Loading, Submerged (No Chem, 24 hr. Sed Time)					X	X
40-F	Activated Al Filter, Slow Load, Submerged (No Chem, 24 hr. Sed Time)	X	X	X	X	X	X
PA	Proprietary Run - Actiflo	X	X	X	X	X	X
PFF	Proprietary Run - Fuzzy Filter	X	X	X	X	X	X
PCA	Proprietary Run - Anion (after Cation) Exchange	X	X	X	X	X	X
CFS	Conventional Run – Floc/Sed	X	X	X	X	X	X
CPSF	Conventional Run – Pressure Sand Filter	X	X	X	X	X	X
CCA	Conventional Run – Anion (after Cation) Exchange	X	X	X	X	X	X

[a] X indicates a sample was collected, analyzed, split, and sent to the laboratory. A blank indicates that no sample was collected.

5.1.2 Quality Assurance

Data received were reviewed with respect to the data quality objectives (DQOs) set forth in the Monitoring and Operations Plan and the procedures established in the Caltrans Guidance Manual, Storm Water Monitoring Protocols (Caltrans, 2000). Data review included electronic validation using the Caltrans *Laboratory Electronic Data Deliverable Error Checker and Automated Data Validation* (Version 2.0) processing tool. Data failing to meet the required quality objectives were issued a qualifier code preceding entry into the database. Detailed validation reports were prepared for all experimental runs (Appendix D). Performance on individual DQOs is presented in this subsection.

Completeness: Completeness can be measured in several ways. Sample completeness can be determined by dividing the number of data points intended for collection by the number of data points actually received or recorded. For this project:

$$\text{Sample Completeness} = \frac{\text{Data Recorded}}{\text{Data Intended}} \text{x} 100\% = \frac{4{,}628}{4{,}630} \text{x} 100\% = 99.96\%$$

This statistic exceeds the DQO of 95 percent set forth in the Monitoring and Operations Plan. There were two data points that were considered unusable. The oil and grease sample for 12-CPSF was reported as <5 mg/L because one of the two bottles required to attain a detection limit of <2 mg/L was broken during handling. Since the surface water discharge limit for oil and grease in the Tahoe Basin is 2 mg/L, the data point is considered to be lost. Additionally, because of a laboratory dilution oversight, one total phosphorus determination (11-31-F) was reported as <0.3 mg/L, rather than the required <0.03 mg-P/L.

A second common definition of completeness is a calculation of the percentage of samples for which results are found to be valid (non-qualified) following quality control assessments. In Phase II, 489 of the 4630 data points were qualified (10.6 percent). Validity is calculated:

$$\text{Data Validity} = \frac{\text{All Data - Qualified Data}}{\text{All Data}} \text{x } 100\% = \frac{4{,}141}{4{,}630} \text{x } 100\% = 89.4\%$$

Nearly 90 percent of the project data are considered validated and able to be used unqualified. The reasons that may cause a data point to be qualified are discussed in subsequent sections. This statistic fails to meet the 95 percent DQO set forth in the Monitoring and Operations Plan. Additional consideration as to the cause of this failure and corrective actions contingencies should be made prior to the onset of Phase III work.

Conformance with Analytical Methods: Analytical methods requested for project determinations were outlined in the project Monitoring and Operations Plan and printed on all sample chain-of-custody forms. Methods specified were consistent with those presented in the Caltrans Guidance Manual, Storm Water Monitoring Protocols (Caltrans, 2000). Analytical methods that deviated from the requested methods for any reason are listed in Table 5-2. The laboratory substitution for endpoint analysis of TKN determination is considered to be acceptable (EPA and ELAP approved).

Table 5-2. Deviations from the Requested Analytical Methods

Parameter	Analytical Method		Experimental Runs	Notes
	Requested	Performed		
Total Kjeldahl Nitrogen (Total and Filtered)	EPA 351.3	EPA 351.1	7-12	EPA 351.3 is a titrimetric ammonia end-point determination. EPA 351.1 determines the end-point using an automated analyzer (automated phenate). Both methods are approved and acceptable.

Reporting Limits: Required project reporting limits were presented in Table 5-1 of the Monitoring and Operations Plan and are summarized in Table 3-4 of this report. A copy of this table was furnished to the laboratory (ToxScan/Soil Control). Required reporting limits were attained, with the exception of the oil and grease sample (12-CPSF) and the total phosphorus (11-31-F) previously mentioned.

Holding Times: Required sample analytical holding times were presented in Table 5-1 of the project Monitoring and Operations Plan and are summarized in Table 3-4 of this report. The holding times indicated are consistent with those specified in the Storm Water Monitoring Protocols (Caltrans, 2000).

Samples for nitrate, nitrite and ortho-phosphate have the shortest holding times (48 hours) of all project samples. As a result, the samples for these constituents were often shipped separately (FedEX). However, based on the logistics and timing of sample collection (e.g., nights and weekends) and transportation to the laboratory (overnight courier services) some sample holding times were exceeded. One hundred fifteen of 4630 sample determinations were not analyzed within approved holding times (2.5 percent). The majority of samples analyzed outside of the holding time were for nitrate, nitrite and total and dissolved orthophosphate. The DQO for holding time compliance set forth in the Monitoring and Operations Plan was 99 percent. This project managed 97.5 percent, thus failing to meet the DQO. Results for samples analyzed outside approved holding time were qualified as "J" (estimated).

Field Blanks: Bottle, equipment, and process field blanks were collected. Bottle blanks allow verification that bottles obtained from the contract laboratory are clean and free from contamination. Additionally, bottle blanks can provide some insight as to the source of any contamination. Bottle blanks were prepared in the field by pouring certified high performance liquid chromatography (HPLC) grade reagent water directly into the sample bottles obtained from the laboratory.

Equipment blanks typically are used to determine if a contaminant is introduced during field sampling or as an artifact of on-site decontamination of sampling equipment. Equipment blanks were prepared by rinsing randomly selected sample equipment (e.g., composite buckets, collection barrels) with HPLC grade reagent water. A bucket of this rinse water was then processed like any other sample.

Process blanks are used to determine if a contaminant is introduced in the processing steps (filtering, handling, splitting) of the sampling. Process blanks were prepared by filling a composite sample bucket with HPLC grade reagent water and processing it like the other samples.

Blanks were sent to the laboratory with no markings indicating that the sample was a blank. A tabular summary of the project blank samples collected are listed in Appendix B, Tables B-3 and B-4. In the tables, contaminant concentrations of concern (i.e. important parameter or one with a greatly elevated concentration) are highlighted in gray. These "hits" received additional scrutiny, often leading to qualifying project results.

Experimental runs having blank contamination were evaluated according to USEPA and Caltrans guidelines (Caltrans, 2000). These guidelines establish the levels at which contamination requires qualification of the data. For sample results that are less than five times the blank concentration, the data are qualified as anomalous "U" (see Section 5.1.3). After reviewing all data, qualifiers were added where necessary to the reported values in the database (Appendix A).

The majority of blank contamination reported was for TKN and TDS determinations. Contamination with respect to TKN showed up in the equipment and process blanks as well as the bottle blanks, leading to the conclusion that the analytical laboratory has some difficulty in low-level analysis of TKN. Similarly, the appearance of TDS in the blanks, while of less project concern, was not detected in field conductivity measurements. Altogether, 262 of 4630 project determinations were qualified due to blank contamination (5.7 percent).

Field Duplicates: The collection and processing (filtering and splitting) of duplicate samples in the field was used to assess precision (i.e., variability attributed to collection, handling, shipment, storage, and/or laboratory processing). Procedures for collecting and processing field duplicates were the same as for normal (non-duplicate) samples. The acceptance (i.e., pass/fail) criterion was based on a calculated relative percent difference (RPD) of less than 50 percent (Caltrans, 2000). The RPD was calculated by dividing the difference between two measurements by the average of the two measurements.

A complete tabular summary of all duplicate project samples is presented in Appendix B, Tables B-5 through B-10 for Runs 7 through 12, respectively. Duplicate pairs that have a RPD exceeding 50 percent are highlighted gray in the tables. Since storm water contains considerable particles and suspended solids, many of the differences between duplicates can be attributed to minute differences in particle makeup and analytical precision. No single analytical determination (parameter) had a large number of rejected duplicate pairs. Three field duplicates were collected for each run, totaling 18 project duplicates. Of the 432 pairs of duplicate results, 19 were tagged as qualified (4.4 percent). After reviewing all duplicate data, qualifiers were added where necessary to the reported values in the database (see Section 5.1.3 and Appendix D).

5.1.3 Data Qualifiers

After quality control analysis, qualifier codes were entered into the database to denote a data entry of suspect quality. The data qualifier codes used were consistent with those found in the Storm Water Monitoring Protocols (Caltrans, 2000). The four most common reasons for data being qualified were:

1. Blank contamination
2. Holding time violation
3. Poor duplicate agreement
4. Dissolved fraction larger than total fraction

The three primary data qualifiers used were "U", "J" and "UJ". The "U" qualifier signifies that the result should be considered to be below the quantitation level for that run. The "U" qualifier was issued for samples with blank contamination. All samples with a reported concentration within five times the concentration detected in the blank were issued "U" qualifiers. The "J" qualifier indicates that the result should be considered approximate, typically due to poor duplicate agreement, missed holding time, or a dissolved concentration reported at a greater concentration than the total concentration. The "UJ" qualifier signifies the reported sample quantitation limit is approximate because of a combination of reasons from the "U" qualifier and the "J" qualifier. Project data qualifiers used and reason code definitions are summarized in Table 5-3. Both qualifiers and reason codes are listed on the database pages prior to the listed result (Appendix A).

Table 5-3. Project Data Qualifiers and Reason Codes

DATA QUALIFIER DEFINITIONS	
U The analyte was analyzed for, but was not detected above the calculated "sample quantitation limit".	J The analyte was positively identified; the associated numerical value is the approximate concentration of the analyte in the sample.
N The analysis indicates the presence of an analyte for which there is presumptive evidence to make a "tentative identification".	NJ The analysis indicates the presence of an analyte that has been "tentatively identified" and the associated numerical value represents its approximate concentration.
UJ The analyte was not detected above the reported sample quantitation limit. However, the reported quantitation limit is approximate and may or may not represent the actual limit of quantitation necessary to accurately and precisely measure the analyte in the sample.	R The sample results are rejected due to serious deficiencies in the ability to analyze the sample and meet quality control criteria. The presence or absence of the analyte cannot be verified.
REASON CODE DEFINITIONS	
a Analytical sequence deficiency or omission.	c Calibration failure; poor or unstable response.
d Laboratory duplicate imprecision.	e Laboratory duplicate control sample imprecision.
f Field duplicate imprecision.	h Holding time violation.
l Laboratory control sample recovery failure.	m Matrix spike/matrix spike duplicate recovery failure.
o Calibration blank contamination (metals/inorganics)	p Preparation blank contamination (metals/inorganics)
q Quantitation outside of linear range.	r Linearity failure in initial calibration.
x Field or equipment blank contamination.	y Trip blank contamination.
z Method blank contamination.	D Value exceeds quantitation limit.
	Q Dissolved concentration significantly exceeded the total concentration.

The most serious data code issued was that of "R" (rejected). Rejected data should not be considered in formulating a conclusion about treatment technologies since the result is not considered valid. Of the 4630 project determinations, 12 individual determinations were rejected (0.26 percent). A list of rejected determinations is summarized in Table 5-4. Six of the 12 rejected values are aluminum determinations (total, dissolved and acid soluble). The primary reason that these aluminum determinations were rejected was that the dissolved or acid soluble component greatly exceeded the total fraction (reason code Q). Lack of precision (f) in the duplicate samples was the next most common reason leading to the rejection of the values.

Table 5-4. Phase II Rejected Sample Determinations

Log #	Parameter	Code	Reasons
12-31-F	Aluminum – Acid Sol	R	Q
12-31-F	Aluminum-dissolved	R	Q
11-37-F	Aluminum-dissolved	R	Q
11-37-F	Aluminum-total	R	Q
11-38-S	Nitrate-Nitrogen	R	f
11-38-S	Organic Carbon-total	R	f
12-PFF	Aluminum – Acid Sol	R	Q
12-PFF	Aluminum-total	R	m Q
9-PFF	Iron-dissolved	R	f Q
9-PFF	Iron-total	R	Q
12-42-S	Nitrate-Nitrogen	R	f
12-42-S	Organic Carbon-total	R	f

5.1.4 Presentation of Treatment Unit Performance

Treatment unit performance with respect to water quality parameters was compiled graphically for presentation in figures located at the end of this chapter. Each figure contains 21 individual plots for a water quality parameter, one for each treatment unit. In each plot or graph, the treatment unit effluent concentration (ordinate) is plotted against the average influent concentration (abscissa) for a particular parameter. Influent values plotted for the non-mechanized treatment units are the averages of results for the two Day 1 samples (I-1 and I-2). Influent values plotted for the mechanized treatments are based on the Day 2 sample (I-3). One (x,y) pair is plotted for each experimental run, up to six total. All treatment units were operated for six runs, except treatment unit 39-F (wollastonite filter) which was operated for two runs. Therefore, all plots have six points except the graphs for the wollastonite filter, which have only two. Some data pairs are exactly equal or close enough to each other that they appear to be a single point. This is common at the reporting limit for some parameters.

Distinguishing characteristics of the data plots are discussed as follows:

Plot Title: Each graph has a title that includes the unit process, media type, sedimentation time, hydraulic regime and the designation number in parenthesis. Unit processes include sedimentation, filtration, Actiflo®, conventional flocculation/sedimentation, Fuzzy Filtration®, pressure sand filtration and ion exchange. Sedimentation times varied from 2- to 24-hours and are abbreviated in the titles as 2hr and 24hr, respectively. Sedimentation tanks were "emptied" by sending the settled storm water to a filter unit either rapidly (by opening a valve for Unit 35-S, only) or slowly, over the course of 6-hours (abbreviated as "6hr Empty" on the plots). Similarly, from a filter standpoint, the units were loaded either rapidly ("Fast Load" for Unit 35-F) or slowly ("6hr Load"). Filters tested were either free drain or submerged (see Chapter 3) and are listed as such in the plot title. The filtration media are spelled out on the plot titles with the exception of "shale", which is an abbreviation for expanded shale. Filter unit titles also included a description of the sedimentation circumstances that proceeded filtration (2- or 24 hours, with and without chemical). Titles above the mechanized plots list the complete treatment up to that point. Unit designations listed on the graphs in parenthesis are the same as those presented in Chapter 3 and used throughout this document.

Reporting Limit Lines: Reporting limit lines are shown on each plot as horizontal and vertical dotted lines. The lines are plotted on both the x-axis and y-axis because both the plant influent and treatment unit effluent samples are subject to the laboratory reporting limit. If a constituent concentration was less than the reporting limit (e.g. < 0.1 mg/L), it is plotted on the reporting limit line (e.g. 0.1 mg/L line). In some cases, the reporting limit line is below the resolution of the plot, so the reporting limit line is not distinguishable from the axis (e.g., turbidity).

Discharge Limit Lines: For regulated parameters, a maximum surface water discharge limit line is shown as a dashed line. Maximum allowable concentrations for discharge to surface waters in the Tahoe Basin (Table 2-1) have been established for turbidity, total-iron, total-nitrogen, total-phosphate (as P) and oil and grease. For these parameters, a line is plotted parallel to the abscissa. If the sample point falls above this line, the effluent concentration is not in compliance with the discharge limit. Conversely, if the sample point falls below this line, the effluent complies with the regulatory criterion.

For the nitrogen compounds (e.g., dissolved nitrogen, nitrate, nitrite, total Kjeldahl nitrogen, and ammonia), the discharge permit line is plotted at the total nitrogen regulatory limit (i.e., 0.5 mg-N/L) even though this limit applies only to the total of the nitrogen compounds. Total nitrogen (a calculated parameter) is presented in its own plot (Figure 5-9). Obviously, if any one individual form of nitrogen exceeds the regulatory limit, the effluent will not be in compliance with the regulatory objective.

In the Lake Tahoe Basin, phosphorus is regulated as "total phosphate as P" at a concentration of 0.1 mg-P/L. It is not clear what form of phosphorus is regulated. Therefore, the discharge permit line is plotted at 0.1 mg-P/L for all of the phosphorus forms. Obviously, if any one individual form of phosphorus exceeds the regulatory limit, the effluent will not be in compliance with the regulatory objective.

One to One (1:1) Influent to Effluent Concentration Line: A solid line bisects each plot diagonally to illustrate equal influent and effluent concentrations (i.e., no increase or decrease in concentration through the treatment process). If the sample point is above this line, the concentration increased through the treatment process and, therefore, indicates deterioration in water quality. If the sample data point is below this line, the concentration decreased through the treatment process.

Mechanized Treatment Systems: Two separate mechanized treatment trains (proprietary and conventional) were operated in Phase II. The proprietary train consisted of the Actiflo® high-rate sedimentation process, followed by Fuzzy Filter® (FF) filtration and cation and anion resin ion exchange. The conventional treatment train consisted of a conventional flocculation and sedimentation batch process, followed by pressure sand filter (PSF) filtration, and cation and anion resin ion exchange. All of the mechanized treatment unit effluent data are plotted against the Day 2 influent data, even though the pressure sand filter, the Fuzzy Filter®, and the ion exchange cartridges actually received partially treated (from the previous process) storm water as influent. Plots for each of the individual processes are presented in the plot pages.

Legend: Most of the plot pages have two legends. The general legend is applicable to all plots except the chitosan sedimentation plot (30-S). A filled diamond indicates a typical (verified) data point. A hollow diamond indicates a qualified data point. A shaded diamond data marker (uncommon) indicates that two points closely occupy the same spot and one of the points is qualified. A hollow square indicates that the data point is one of the 12 data points that are rejected. The chitosan sedimentation legend uses different data markers to reflect the three different net doses of chitosan.

5.2 Treatment Results

Treatment results for the various water quality parameters are discussed separately below.

5.2.1 Turbidity

Turbidity is a measure of light scatter, and is attributed to suspended and colloidal particles. Sources of particles in storm water runoff include clay and silt from erosion, organic detritus, atmospheric deposition of particulate emissions, etc. The Lake Tahoe Basin discharge limit for turbidity is 20 NTU for surface water discharge and 200 NTU for discharge to infiltration systems.

Sedimentation and filtration are expected to reduce turbidity because the processes directly remove the particles that are responsible for light scatter. Chemical addition is expected to reduce turbidity because it aids in coagulating many small particles into fewer larger particles that either scatter less light or can be subsequently removed by sedimentation or filtration. Turbidity reduction through the various treatment processes is illustrated in Figure 5-1. Three of the 15 non-mechanized treatment systems (filters and various sedimentation processes) were able to produce an effluent that consistently complied with the surface water regulatory effluent limit of 20 NTU. Those systems were:

- Fine sand filter, 6-hr load, free drain following PASS-C®, 2-hr sedimentation (34-F)
- Expanded shale filter, 6-hr load, submerged drain following 24-hr sedimentation (37-F)
- Sedimentation, 24-hr, with liquid chitosan (30-S) (when dosed at ~1 mg/L)

Narrowly missing compliance with the 20 NTU criterion in one run was:

- Activated alumina filter, 6-hr load, submerged drain following 24-hr sedimentation (40-F)

The activated alumina filter (40-F) removed turbidity to below the surface water regulatory limit in all except Run 12, which had the highest influent turbidity (576 NTU). For this run, the effluent turbidity was 23.8 NTU. The limestone filter (38-F) reduced turbidity to below the surface water regulatory limit until Runs 11 and 12, which had high influent turbidities.

Chitosan-enhanced sedimentation, when the target dose of 1 mg/L was attained (using the liquid formulation), reduced the turbidity to below the surface water limit in 3 experimental runs. The addition of PASS-C® also greatly increased turbidity removal during sedimentation; however, this treatment alone (without subsequent filtration) was not sufficient to consistently meet the surface water regulatory limit, though it was close, with effluent turbidities ranging from 1 to 55 NTU.

All of the mechanized processes (6 of 6) were able to produce an effluent that complied with the surface water regulatory effluent limit of 20 NTU in all six runs. These systems were:

- Actiflo® (PA)
- Actiflo® and Fuzzy® filtration (PFF)
- Actiflo®, Fuzzy® filtration and ion exchange (PCA)
- Conventional Floc/Sed (CFS)
- Conventional Floc/Sed and pressure sand filtration (CPSF)
- Conventional Floc/Sed, pressure sand filtration and ion exchange (CCA)

For the proprietary mechanized treatment systems, most of the turbidity removal occurred in the Actiflo® high-rate sedimentation process. The downstream Fuzzy Filter® and ion exchange units only slightly improved turbidity removal. Similarly, for the non-proprietary mechanized treatment systems, conventional coagulation, flocculation and sedimentation removed the turbidity to below 20 NTU in all experimental runs. The downstream pressure sand filter and ion exchange units had little effect on turbidity.

With respect to the standard of 200 NTU for discharge to infiltration systems, 6 of the non-mechanized and all of the mechanized treatment systems were able to attain this level. However, the influent was less than 200 NTU in 3 of the 6 experimental runs. The following treatment units were able to consistently meet the turbidity discharge limit for discharge to infiltration systems:

- Sedimentation, 2-hr, with PASS-C® (34-S)
- Sedimentation, 24-hr, with liquid chitosan (30-S)
- Fine sand filter, 6-hr load, free drain, following 2-hr sedimentation (32-F)

- Fine sand filter, 6-hr load, free drain, following PASS-C®, 2-hr sedimentation (34-F)
- Expanded shale filter, 6-hr load, submerged drain, following 24-hr sedimentation (37-F)
- Activated Alumina Filter, 6 hr. Load, Submerged Drain, Following 24-hr sedimentation (40-F)
- Actiflo® (PA)
- Actiflo® and Fuzzy® filtration (PFF)
- Actiflo®, Fuzzy® filtration and ion exchange (PCA)
- Conventional Floc/Sed (CFS)
- Conventional Floc/Sed and pressure sand filtration (CPSF)
- Conventional Floc/Sed, pressure sand filtration and ion exchange (CCA)

5.2.2 Total Suspended Solids

Total suspended solids (TSS) represents the concentration of solid material that is retained on a glass fiber filter (nominal pore size = 0.45 μm) after sample filtration and drying at 103°C. Sources of total suspended solids are similar to the sources of turbidity. A fixed and precise correlation between turbidity and total suspended solids in storm water is not possible because the size, shape, and refractive index of particles are variable.

The removal of TSS through the various treatment processes is illustrated in Figure 5-2. Total suspended solids do not have a specific numerical effluent limit listed in the Basin Plan. However, some general overall water quality standards for the Lake Tahoe Basin are listed in the Lahontan Basin Plan, including the following: *"Suspended sediment concentrations in the streams tributary to Lake Tahoe shall not exceed a 90th percentile value of 60 mg/L"*. Application of this standard would require consideration of the available dilution in receiving streams.

Average influent TSS was 222 mg/L. Sedimentation alone, with 2- or 24-hour settling times reduced TSS loads 42 percent and 65 percent, respectively. Typical media filter effluents following 24-hour sedimentation were less than 10 mg/L. The Actiflo® process produced an effluent containing less than 1 mg/L TSS in all but one run, where the effluent had 4 mg/L (Run 11, qualified result). The non-proprietary floc/sed process produced an effluent containing a range from 12 to <1 mg/L TSS.

5.2.3 Oil and Grease

Oil and grease in storm water runoff can originate from a variety of sources, including hydrocarbons (non-volatile petroleum compounds) associated with vehicles and oils and waxy compounds extracted from plant and vegetable matter. Oil and grease can be removed from water by physical separation and adsorptive processes. Therefore, coagulation and filtration are expected to reduce concentrations of oil and grease in storm water, though not entirely eliminate their presence if they occur in relatively high concentrations.

The Tahoe Basin numeric storm water discharge limit for oil and grease is 2 mg/L for surface water discharge and 40 mg/L for discharge to infiltration systems. The average oil and grease concentration of the storm water used in the pilot plant was 5 mg/L. Experimental Runs 9, 10 and 12 had no detectable oil and grease in the influent (roadside basins, and snow storage yard). The mean EMC Tahoe Basin storm water oil and grease (reported in the 2001-2002 basin survey) was 22 mg/L (Caltrans 2002b). In general, Tahoe storm water runoff may fall below the requirement of 40 mg/L for discharge to infiltration systems.

The removal of oil and grease through the various treatment processes is illustrated in Figure 5-3. Because of the low oil and grease concentrations in the storm water tested, definitive conclusions about treatment process effectiveness in removing oil and grease cannot be made. Additionally, the fact that oil and grease concentrations can be reduced via handling (e.g., pumping, transferring storm water from tank to tank that allows oil and grease to adhere to surfaces or remain behind) complicates interpretation of process effectiveness with respect to oil and grease removal. With this being noted, none of the non-mechanized sedimentation processes alone (without chemicals) were able to consistently reduce oil and grease to below the limit of 2 mg/L for discharge to surface water. However, several of the filter units (following sedimentation) and all of the mechanized systems were consistently able to attain this level. Successful treatment processes for removing oil and grease to at or below 2 mg/L were:

- Sedimentation, 24-hr, with liquid chitosan (30-S) (when dosed at ~1 mg/L)
- Fine sand filter, 6-hr load, free drain, following 24-hr sedimentation (31-F)
- Fine sand filter, 6-hr load, submerged drain, following 2-hr sedimentation (33-F)
- Fine sand filter, 6-hr load, submerged drain, following 24-hr sedimentation (36-F)
- Fine sand filter, 6-hr load, free drain, following PASS-C®, 2-hr sedimentation (34-F)
- Limestone filter, 6-hr load, submerged drain, following 24-hr sedimentation (38-F)
- Activated alumina filter, 6-hr load, submerged drain, following 24-hr sedimentation (40-F)
- Actiflo® (PA)
- Actiflo® and Fuzzy® filtration (PFF)
- Actiflo®, Fuzzy® filtration and ion exchange (PCA)
- Conventional Floc/Sed (CFS)
- Conventional Floc/Sed and pressure sand filtration (CPSF) (barring one qualified result)
- Conventional Floc/Sed, pressure sand filtration and ion exchange (CCA)

Several other treatment systems attained or nearly attained an effluent with < 2 mg/L of oil and grease in all but one run (see Figure 5-3). As stated earlier, the influent used contained < 2 mg/L oil and grease in 3 of the 6 runs. The influent was always below the 40mg/L level required for discharge to infiltration systems.

5.2.4 Phosphorus

Phosphorus can be present in storm water as orthophosphate, polyphosphate, or organically bound phosphorus. Phosphorus in water is typically complexed and bound with organic and inorganic particles, thus it is usually associated with sediment and biomass. Free "available" phosphate in natural waters is quickly bound or utilized by microorganisms and, therefore, typically is present at low concentrations. Sources of phosphorus include soils, fertilizers, wastes, and cleaners.

During the pilot project, monitoring was conducted for total phosphorus on unfiltered and filtered samples (resulting in measurements of total and dissolved phosphorus) and filtered and unfiltered orthophosphate (resulting in measurements of orthophosphate total and orthophosphate dissolved). Dissolved phosphorus includes orthophosphate and dissolved forms of polyphosphate and organic phosphorus. True orthophosphate is always dissolved, so any differences between test results between unfiltered and filtered (total and dissolved) orthophosphate could represent particles containing orthophosphate precipitated with iron, for example. In the analytical test procedure for orthophosphate on unfiltered samples, these precipitates would dissolve and be measured as orthophosphate. Further evidence of the association of orthophosphate with particles can be seen in the observation that the total orthophosphate concentration measured in the influents was often ten times larger than the measured dissolved phosphorus (Table 4-8).

It is expected that treatment processes that remove particles (e.g., sedimentation, filtration) will remove particulate phosphorus. Chemical addition is expected to enhance particulate phosphorus removal because it aids in coagulating many small particles into fewer larger particles that can subsequently be physically removed by sedimentation and/or filtration. Additionally, chemical addition can be used to remove dissolved phosphorus through complexation, sequestration and precipitation mechanisms. The chemical coagulant PASS-C® was specifically chosen for pilot project study due to its demonstrated ability to remove dissolved phosphorus during the Jar Test Study (Caltrans, 2003).

Total phosphorus reduction through the various treatment processes is illustrated in Figure 5-4. Dissolved phosphorus reduction is illustrated in Figure 5-5. The reductions of total and dissolved ortho-phosphate through the various treatment processes are illustrated in Figures 5-6 and 5-7, respectively. The relative amounts of total and dissolved forms of phosphorus before and after treatment in each unit are illustrated in Figure 5-8. The Basin Plan specifies a maximum "total phosphate as P" of 0.1 mg/L for surface discharge and 1 mg/L for discharge to infiltration systems. Furthermore, the Basin Plan specifies that total phosphate is measured as total phosphorus (LRWQCB, 1994).

Total Phosphorus: The majority of phosphorus in Tahoe Basin storm water was in the particulate form (in all but Run 10) and therefore, theoretically subject to removal by solids/liquid separation processes (e.g., sedimentation and filtration). In Phase II, the mean influent total phosphorus was 0.52 mg-P/L, which is lower than the Phase I mean of 0.80 mg-P/L. The mean Phase II dissolved phosphorus concentration was 0.03 mg-P/L, which is lower than the Phase I mean of 0.20 mg-P/L. In Phase II, the removal of particulate

phosphorus alone would allow for compliance with the surface water discharge standard of 0.1 mg-P/L.

Graphs of the removal of total phosphorus in the various treatment systems are shown in Figure 5-4. Three of the non-mechanized processes were able to consistently attain total phosphorus removal below 0.1 mg-P/L. Those systems were:

- Fine sand filter, 6-hr load, free drain, following PASS-C®, 2-hr sedimentation (34-F)
- Activated alumina filter, 6-hr load, submerged drain, following 24-hr sedimentation (40-F)
- Sedimentation, 24-hr, with liquid chitosan (30-S) (when dosed at ~1 mg/L)

Two other non-mechanized systems nearly always attained the surface water discharge requirement for total phosphorus. Those systems were:

- Expanded shale filter, 6-hr load, submerged drain, following 24-hr sedimentation (37-F)
- Sedimentation, 2-hr, with PASS-C® (34-S)

The expanded shale media removed total phosphorus to below 0.1 mg-P/L in 5 out of 6 experimental runs. Shale filtration following 24-hour sedimentation in Experimental Run 11 had an effluent total phosphorus concentration of 0.13 mg-P/L. Similarly, sedimentation with PASS-C® alone was successful in 5 of 6 runs, failing also in Experimental Run 11 (effluent = 0.12 mg-P/L).

All of the mechanized processes (6 of 6) were able to produce an effluent total phosphorus concentration that consistently complied with the surface water regulatory effluent limit of 0.1 mg-P/L. These systems were:

- Actiflo® (PA)
- Actiflo® and Fuzzy® filtration (PFF)
- Actiflo®, Fuzzy® filtration and ion exchange (PCA)
- Conventional Floc/Sed (CFS)
- Conventional Floc/Sed and pressure sand filtration (CPSF)
- Conventional Floc/Sed, pressure sand filtration and ion exchange (CCA)

For the proprietary mechanized treatment systems, virtually all of total phosphorus removal took place in the first treatment process (Actiflo® or the conventional coagulation, flocculation and sedimentation process).

The storm water runoff used in Phase II contained <1.0 mg-P/L of total phosphorus in 6 of 6 experimental runs with one exception - Day 2 influent (I-3) for Experimental Run 10, used to supply the mechanized systems, measured 1.1 mg-P/L total phosphorus. The total phosphorus limit for discharge to infiltration systems within the Tahoe Basin is 1 mg-P/L. Therefore, due to the lack of total phosphorus in the influent, no conclusion can be made about the treatment systems ability to comply with the discharge requirements for infiltration systems. Systems that are able to comply with the lower total phosphorus limit required for discharge to surface water (<0.1 mg-P/L) should also able to comply to the higher 1 mg-P/L

limit, but the technologies have not been tested at higher phosphorus levels to validate such a conclusion.

Dissolved Phosphorus: As illustrated in Figure 5-5, influent dissolved phosphorus was always below the surface water discharge limit of 0.1 mg/L (as total phosphorus). The treatment systems that were expected to remove dissolved phosphorus were chemical precipitation (with PASS-C®), adsorptive filter media (activated alumina, expanded shale and limestone), and ion exchange. Treatment units with PASS-C® addition and activated alumina media were observed to remove some dissolved phosphorus, although the dissolved phosphorus levels are generally very low.

Many of the non-mechanized treatment processes showed a slight increase in effluent dissolved phosphorus concentrations. All of the non-mechanized filtration media tested showed some production (increase) of dissolved phosphorus (as illustrated by data points above the unit slope lines in the graphs presented in Figure 5-5). Some dissolved phosphorus production is likely due to the dissolution of soluble phosphorus attached to particulates over time. Based on 1-2 data points, sedimentation alone may have increased dissolved phosphorus levels slightly. After solid material has accumulated on the filter media, dissolved phosphorus can be released due to decomposition of trapped organic particles.

Orthophosphate: Virtually all of the orthophosphate found in the Tahoe Basin storm water collected was in the total (non-filtered) form (see Table 4-8). In Phase II, the mean influent total orthophosphate was 0.27 mg-P/L, which is somewhat greater than the Phase I mean of 0.21 mg-P/L. Dissolved orthophosphate levels in both project phases were nearly always less than the reporting limit 0.03 mg-P/L. The removal of total orthophosphate (Figure 5-6) by the treatment technologies tested closely tracked the removal of total phosphorus. Because of the small amount present, no conclusion can be made for the removal of dissolved orthophosphate.

5.2.5 Nitrogen

Nitrogen is an essential nutrient for biological growth. Inorganic nitrogen is present in storm water primarily as nitrate and ammonia and to a lesser extent as nitrite. Sources of inorganic nitrogen include fertilizers, animal and domestic wastes, household cleaners and the decay of organic matter. Organic nitrogen, commonly calculated as total Kjeldahl nitrogen (TKN) minus ammonia, typically originates from biological material (plants, algae, animal wastes, etc.). In this project, the nitrogen forms measured were total and dissolved TKN, ammonia, nitrate, and nitrite (all expressed as N). Particulate organic nitrogen can be determined by subtracting dissolved TKN (filtered) from total TKN (unfiltered). Dissolved organic nitrogen can be determined by subtracting ammonia from dissolved TKN. Total nitrogen can be calculated as the sum of nitrate + nitrite and TKN-T (unfiltered or "total" TKN).

Particulate nitrogen can be filtered and potentially settled. Biodegradation of the captured particles can, however, produce dissolved nitrogen-containing constituents, particularly nitrate. Dissolved organic nitrogen and ammonia can be removed from storm water by adsorption. In the dry periods between storms, microorganisms will frequently convert these constituents to nitrate, which does not adsorb onto most media. Thus, at least some of the

nitrogen captured in one storm may potentially be released in the next. Nitrate can be converted to nitrogen gas by biological denitrification, but conditions that promote this process (particularly a lack of oxygen) are not usually present in settling basins and filters that dry out between storms.

Total nitrogen removals through the various treatment processes are illustrated in Figure 5-9. The removals of dissolved nitrogen, ammonia, nitrate, nitrite, total TKN, and dissolved TKN through the various treatment processes are illustrated in Figure 5-10, Figure 5-11, Figure 5-12, Figure 5-13, Figure 5-14, and Figure 5-15, respectively. The various forms of nitrogen before and after treatment in each of the treatment units and for each run are illustrated in Figure 5-16.

Total Nitrogen: Total nitrogen was calculated as the sum of TKN-T + nitrate + nitrite; even though many of the Phase II dissolved TKN (TKN-D) values were higher than the totals (TKN-T). Many of the TKN data are qualified as estimated or approximate; however none were rejected. In Phase II, the mean influent total nitrogen was 0.89 mg-N/L, which is substantially lower than the Phase I mean of 2.6 mg-N/L. The fractions of particulate and soluble organic nitrogen varied greatly in the influent storm water (Figure 5-16). As in Phase I, some removal of dissolved nitrogen is desirable to be able to consistently attain total nitrogen compliance.

The Basin Plan specifies a maximum surface water discharge for total nitrogen of 0.5 mg-N/L and 5 mg/L for discharge to infiltration systems. As illustrated in Figure 5-9, five of the non-mechanized treatment processes and all of the mechanized treatments consistently met the total nitrogen surface water discharge standard. These treatments were:

- Sedimentation, 2-hr, with PASS-C® (34-S)
- Sedimentation, 24-hr, with liquid chitosan (30-S) (when dosed at ~1 mg/L)
- Fine sand filter, 6-hr load, free drain following PASS-C®, 2-hr sedimentation (34-F)
- Shale filter, 6-hr load, submerged drain following 24-hr sedimentation (37-F)
- Activated alumina filter, 6-hr load, submerged drain following 24-hr sedimentation (40-F)
- Actiflo® (PA)
- Actiflo® and Fuzzy® filtration (PFF)
- Actiflo®, Fuzzy® filtration and ion exchange (PCA)
- Conventional Floc/Sed (CFS)
- Conventional Floc/Sed and pressure sand filtration (CPSF)
- Conventional Floc/Sed, pressure sand filtration and ion exchange (CCA)

One other non-mechanized treatment system was nearly able (5 of 6 runs) to meet the total nitrogen surface water discharge limit of 0.5 mg-N/L. That system was:

- Limestone filter, 6-hr load, submerged drain, following 24-hr sedimentation (38-F)

The same non-mechanized units that were effective at removing turbidity and suspended solids were also generally able to lower total nitrogen levels to below the 0.5 mg-N/L limit, primarily via the removal of particulate total nitrogen (see Figure 5-16). Chemically assisted sedimentation processes (Units PA, CFS, 34-S and 30-S, when dosed at the target level) were able to lower the total nitrogen concentration in the effluent to below the surface water discharge limit in all runs; again, primarily by the removal of particulate total nitrogen (see Figure 5-16). The reduction of total nitrogen to below the surface discharge limit using chemically enhanced sedimentation processes was not observed in Phase I, where the influent storm water contained higher nitrogen levels.

Soluble organic nitrogen (dissolved TKN – ammonia) generally passed through the treatment systems unchanged (Figure 5-16). None of the treatment systems were expected to remove appreciable quantities of dissolved forms of nitrogen; with the exception of the ion exchange units (associated with the mechanized equipment) that theoretically are able to remove ammonia, nitrate and nitrite.

All treatment systems produced an effluent containing less than 5 mg-N/L of total nitrogen (the discharge limit for infiltration systems within the Tahoe Basin). However, the influent storm water used in this study contained < 5 mg-N/L in all six experimental runs. If the majority of total nitrogen is particulate, several of the treatment technologies may be able to attain this level of treatment.

Kjeldahl Nitrogen: The Phase II influent storm water contained almost no ammonia, nitrate or nitrite. Therefore, TKN-T removal throughout the treatment systems represents organic nitrogen removal and closely tracks the observations noted for total nitrogen.

As observed with dissolved phosphorus, some of the treatment systems appeared to produce dissolved TKN (Figure 5-15). Unlike phosphorus, the production of TKN-D in the filters was spotty and inconsistent. Based on the number of TKN determinations being qualified (failing QC checks), however, no real conclusions can be drawn regarding TKN-D production. The data may be a result of analytical errors (i.e. method blank contamination).

Nitrate Nitrogen: The Phase II influent storm water contained no measurable nitrate (<0.1 mg-N/L), with the exception of a single Day 2 observation of 0.11 mg-N/L (10-I-3, a qualified value). Therefore, the presence of nitrate in the treatment system effluents can be attributed to conversion, production or dissolution of organic nitrogen materials.

Significant quantities of nitrate nitrogen (0.2 to 0.7 mg-N/L) were produced primarily in the fine sand filters, both free and submerged drain configurations, and to a lesser extent, the fine sand filter unit preceded by sedimentation with PASS-C®. Nitrate production in the sand filters was typically greater after an extended period between runs (Runs 7, 9 and 11 all had at least 2 weeks between operations). During inactivity, the filter media itself remains somewhat moist and some water remains in the underdrain. Nitrate formation in the sand filters may be due to biological activity whereby trapped organic nitrogen is converted to ammonia and then nitrified (converted to nitrite then nitrate); however, no production of ammonia or nitrite was noted (Figures 5-11 and 5-13). Appreciable nitrate production was not observed in the activated alumina, expanded shale, limestone, or wollastonite filter

media, suggesting that conditions in these media filters were not as conducive to potential biological activity, perhaps due to the higher pH levels found in these media. In the case of wollastonite, which was operated for only two runs, length of time in service may have been a factor. The addition of PASS-C® may have removed enough organic nitrogen (or bacteria) to prevent potential biological transformation of nitrogen. Alternatively, PASS-C® could otherwise act to prevent or inhibit the biological conversions in the sand filter.

5.2.6 Total and Dissolved Iron

Iron (Fe) is a metal found in various particulate and dissolved (soluble) forms. It is vital to plant and animal life. The proportion of dissolved iron present in water is dependent on the solubility, concentration, oxidation state, and presence of complexation agents. Iron is the fourth most abundant rock-forming element and occurs naturally in soils and water. Erosion of soils and dust deposition is therefore a common source of iron in storm water runoff. Vehicular sources can also be substantial, as lubricants, brake materials, tire-wear particulates and automotive body and frame parts all are known sources of iron in roadway runoff (FHA, 2000).

Of the various forms of iron, only total and dissolved iron was monitored. Total iron was present in the Phase II influent at concentrations ranging from 743 to 20,667 µg/L (0.74 to 20.6 mg/L). Dissolved iron was present in concentrations ranging from <25 to 117 µg/L (0.025 to 0.117 mg/L). The Lake Tahoe Basin total iron effluent limitations are 500 µg/L (0.5 mg/L) for discharge to surface waters and 4000 µg/L (4 mg/L) for discharge to infiltration systems (LRWQCB, 1994).

Total iron removal through the various treatment processes is illustrated in Figure 5-17. Dissolved iron removal is illustrated in Figure 5-18. For all of the experimental runs, the influent dissolved iron was below the regulatory effluent limitation. Therefore, removal of particulate iron alone would allow compliance.

Three of the non-mechanized treatment systems were able to produce an effluent that consistently complied with the permit regulatory limit of 500 µg/L for total iron. These treatments were:

- Sedimentation, 24-hr, with liquid chitosan (30-S) (when dosed at ~1 mg/L)
- Fine sand filter, 6-hr load, free drain following PASS-C®, 2-hr sedimentation (34-F)
- Expanded shale filter, 6-hr load, submerged drain following 24-hr sedimentation (37-F)

One system was able to attain the surface water discharge limit in 5 of 6 runs:

- Activated alumina filter, 6-hr load, submerged drain, following 24-hr sedimentation (40-F)

With refinements, PASS-C® enhanced sedimentation (34-S) may be able to reliably attain the limit of 500 µg/L for total iron.

All of the mechanized treatment systems consistently removed total iron to below the surface water discharge limit (500 µg/L). These treatments were:

- Actiflo® (PA)
- Actiflo® and Fuzzy® filtration (PFF)
- Actiflo®, Fuzzy® filtration and ion exchange (PCA)
- Conventional Floc/Sed (CFS)
- Conventional Floc/Sed and pressure sand filtration (CPSF)
- Conventional Floc/Sed, pressure sand filtration and ion exchange (CCA)

Actiflo® treatment alone exhibited sufficient iron removal to comply with the surface water discharge limit. The addition of the Fuzzy Filter® and ion exchange units increased iron removal somewhat, the magnitude being influenced primarily by the influent total iron concentration. Similarly, the conventional coagulation, flocculation and sedimentation treatment step removed sufficient iron to comply with the surface water discharge limit, with some additional iron removal observed in the pressure sand filter and ion exchange units.

Two of the non-mechanized units that did not consistently meet the surface water limits were able to consistently meet the less stringent infiltration standard (4,000 µg/L). They were:

- Sedimentation, 24-hr, with PASS-C® (34-S)
- Activated alumina filter, 6-hr load, submerged drain following 24-hr sedimentation (40-F)

5.2.7 Aluminum

There is no current regulatory requirement to remove aluminum from storm water in the Lake Tahoe Basin; however, the United States Environmental Protection Agency has stated that aluminum concentrations in excess of 87 µg/L have the potential to cause chronic aquatic life toxicity (Brooke and Stephan, 1988). There is some controversy, however, regarding the state of aluminum that most contributes to aquatic life toxicity. Acid-soluble aluminum has been reported as being the best descriptor of aluminum toxicity (USEPA, 1988), but it has substantial deficiencies that preclude its universal use in setting regulations.

The removal of total, acid-soluble, and dissolved aluminum through the various treatment processes is illustrated in Figure 5-19, Figure 5-20, and Figure 5-21, respectively.

The following treatment units (including non-mechanized and mechanized systems) were able to consistently comply with an effluent total aluminum concentration of 87 µg/L:

- Fine sand filter, 6-hr load, free drain following PASS-C®, 2-hr Sedimentation (34-F)
- Actiflo® and Fuzzy® filtration (PFF)
- Actiflo®, Fuzzy® filtration and ion exchange (PCA)
- Conventional Floc/Sed, pressure sand filtration and ion exchange (CCA)

All of the processes listed above (neglecting two data points with acid soluble aluminum greater than total aluminum for the PFF unit), and the following two treatments were able to consistently meet 87 µg/L acid soluble aluminum:

- Sedimentation, 24-hr, with liquid chitosan (30-S) (when dosed at ~1 mg/L)
- Conventional Floc/Sed and pressure sand filtration (CPSF)

The activated alumina and shale filters appeared to substantially increase the concentration of dissolved and acid soluble aluminum, thus potentially increasing the toxicity of the effluent. Increased concentrations of dissolved aluminum could be due to re-partitioning of aluminum occurring within the filters (due to pH and aluminum solubility reactions), or the filter media itself contributing a leaching fraction of dissolved aluminum. Both of the filters with elevated dissolved aluminum concentrations also had the highest pH levels. Whether the elevated pH in these media contributed to the increased dissolved aluminum is not known. Neither is it known whether the increases in dissolved aluminum would diminish with continued filter operation.

5.2.8 Other Water Quality Parameters

pH: The Lahontan Basin Plan water quality objective for the pH of surface water is that "the pH shall not be depressed below 6.5 nor raised above 8.5" (LRWQCB, 1994). Phase II influent storm water had a pH range between 6.8 and 7.9. Influent and effluent pH values for all of the treatment units are illustrated in Figure 5-22.

As shown in Figure 5-22, the fine sand filter media and sedimentation with chitosan had little effect on the pH of the storm water. The use of PASS-C® in both the non-mechanized and mechanized systems resulted in a slight reduction of pH, sometimes producing effluent pH values as low as or somewhat below 6.5.

All of the alternative filter media (activated alumina, limestone, wollastonite, and expanded shale) increased the pH level of the storm water being treated. Filtration with limestone sometimes resulted in pH greater than 8.5, while activated alumina, wollastonite, and shale always resulted in a pH greater than 8.5. Activated alumina was observed to increase the pH by 1.0 to 2.1 units, resulting in effluent pH values ranging from 8.8 to 9.5. In two runs, the wollastonite media was observed to increase the pH 1.7-1.8 pH units (effluent pH = 9.1 in both runs). Filtration with expanded shale resulted in the greatest increase in pH, with an average increase of 3.8 units and effluent pH ranging from 10.9 to 11.5. It should be noted that the pH level of the effluent is not presently regulated within the Tahoe Basin. The effect of filter effluents on regulated receiving waters requires consideration of dilution and mixing conditions.

Alkalinity: Alkalinity is a measure of the capacity to neutralize acid. In the case of treatments that result in high pH values, the alkalinity provides an indication of the amount of acid that would be required to reduce the pH to acceptable levels.

The changes in alkalinity throughout the treatment systems are presented in Figure 5-23. As would be expected, treatments that had little effect on pH also had little effect on alkalinity, while treatments that increased pH increased alkalinity and treatments that decreased pH also decreased alkalinity. Filtration with expanded shale increased the alkalinity an average of 94 mg-$CaCO_3$/L. Filtration with activated alumina, while increasing the pH 1-2 units, had little effect on effluent alkalinity.

Total Dissolved Solids and Conductivity: The expanded shale filter media increased the storm water total dissolved solids content (Figure 5-24) by an average of 231 mg/L.

Correspondingly, the expanded shale media also increased electrical conductivity (not graphed) by an average of 400 µmhos/cm. The activated alumina, however, decreased the electrically conductivity of the storm water in 3 of the 6 runs, by as much as 590 µmhos/cm (Experimental Run 11). Other treatments typically had little effect on TDS.

5.3 Technology Assessments

The technology assessments are based on the overall contaminant removals described in Section 5.2. The observed performance of chemical addition, filter variations, non-mechanized and mechanized treatments, and differences between Phases I and II observations are presented in this section.

5.3.1 Sedimentation, 2-Hour vs. 24-Hour Sedimentation

A comparison of 2- and 24-hour sedimentation (without chemical addition) effect on contaminant removal is presented graphically in the top row of plots in Figure 5-25. Twenty-four hour sedimentation (the average of 36-S and 38-S) is presented on the ordinate and 2-hour sedimentation (Unit 33-S) is plotted on the abscissa. Both treatments were slowly drained (fed to the corresponding fine sand filters) over a 6-hour period. When the data points fall below the 45-degree line, the treatment was better for 24-hour sedimentation than for 2-hour sedimentation. As can be seen from the plots of the regulated constituents, there was little benefit to using the longer 24-hour sedimentation period versus a shorter 2-hour sedimentation time. On the average, the 2-hour sedimentation process removed 27 percent of the turbidity, 13 percent of the total phosphorus, 11 percent of the total nitrogen, 20 percent of the oil and grease, and 30 percent of the total iron from the influent. The 24-hour sedimentation process removed 39 percent of the turbidity, 27 percent of the total phosphorus, 17 percent of the total nitrogen, 34 percent of the oil and grease, and 40 percent of the total iron from the influent.

When followed by slow load fine sand filters, whether submerged or free-draining, there was no significant difference in performance of the overall treatment system based on 24-hours versus 2-hours sedimentation time (Figure 5-26).

Note that all of the storm water used in this study (and the previous Phase I) was collected from roadside traps, basins or boxes designed to induce sedimentation and detain runoff. Even though the storm water used was collected during rain events when the above listed devices were actively discharging, the storm water sample itself has undergone some initial sedimentation and therefore may not fully represent field conditions. The resulting sample collected for pilot use and testing is likely biased towards containing particles and suspended solids that settle more slowly.

5.3.2 Chitosan Sedimentation

To increase contaminant removal during sedimentation, chitosan was fed into treatment Unit 30-S. Chitosan was dosed while filling the tank with storm water and the tank contents allowed to settle for 24 hours. After 24 hours, the tank was drained slowly (upper half), over 6-hours. For Runs 7 and 8, chitosan was fed into the sedimentation tank using the passive

"tea bag" approach to dissolve dry chitosan into the influent storm water. Poor results were obtained, most likely due to inadequate dosing of chitosan. For the remaining runs, liquid chitosan was fed with a target dose rate equivalent to 1 mg of dry chitosan per liter of storm water. The target dose (1 mg/L) was not attained in Experimental Run 9 (a net dose of 0.53 mg/L was attained). For Experimental Runs 10 through 12, a dose of approximately 1 mg/L was attained. Therefore, the results from the last three experimental runs are of primary interest.

In Runs 10, 11, and 12, when chitosan was fed as a liquid at 1 mg/L, 24-hour sedimentation with chitosan performed substantially better than 2- or 24-hour sedimentation without chemicals. At a 1mg/L dose, chitosan-enhanced sedimentation was consistently able to attain the surface water discharge limits for all regulated parameters. For the last three runs, chitosan performance was superior to that of PASS-C® enhanced sedimentation; however, chitosan sedimentation was for 24-hours, while PASS-C® sedimentation was for 2-hours only. It is unknown how the two chemicals would compare with equal sedimentation times.

5.3.3 PASS-C® Sedimentation

Similar to Phase I, PASS-C®, a poly-aluminum chloride coagulant, was added to improve sedimentation (2 hour). However, in Phase II, jar tests were conducted on-site each experimental run to determine the optimal dose. This optimal dose varied from 75 to 200 mg/L. The relationship between optimal PASS-C® dose and influent turbidity is presented in Figure 5-27. The highest dose of PASS-C® was required for the lowest influent turbidity, a common observation with clear waters. The lowest optimum PASS-C® doses occurred with mid-range turbidities (100 to 400 NTU). As turbidity increased above these middle ranges, so did the amount of PASS-C® required for optimal treatment (Figure 5-27). These results are based on turbidity evaluations in jar tests after 15 minutes of settling time. In Phase I, a blanket dose of 100 mg/L PASS-C® was used for all storm water runoff tested with reasonable success (Phase I influent turbidity values ranged from 66 to 1,038 NTU, with an average 539 NTU). From Figure 5-27, a dose of 100 mg/L PASS-C® appears to be adequate but perhaps slightly low.

Jar test results using the optimized PASS-C® dose and a fixed 100 mg/L dose were compared to determine if the optimized dose improved the removal of phosphorus. While conducting the jar testing to determine optimal PASS-C® dose, jars containing the optimized dose (based on lowest turbidity after 15 minutes of settling) and the jar containing the 100 mg/L dose were set aside and allowed to settle for 2 hours. After 2 hours, samples for total and dissolved phosphorus and turbidity were collected. The comparison of removal rates for a fixed versus an optimized dose for jar tests is illustrated in Figure 5-28. In Figure 5-28, data points below the 45-degree line indicate that the optimum dose performed better than the 100 mg/L fixed dose. As can be seen, the optimized PASS-C® dose always resulted in somewhat better performance than the 100 mg/L dose for the removal of total phosphorus. However, the phosphorus surface discharge was met in all but one test with the fixed dose. Results for turbidity show that both doses could easily attain the 20 NTU surface water discharge limit. Optimizing dose at a full-scale level would be operator intensive and may provide minimal benefit at removing regulated contaminants. Continued data collection of coagulant optimal

dose would be useful information for the eventual determination of a fixed dose optimal level.

The PASS-C® dosed 30-inch sedimentation tank (2-hour sedimentation time) was a successful treatment process (Unit 34-S). While alone, this unit did not consistently produce effluent that complies with the surface water discharge limits, it was able to meet the limits for infiltration consistently. On the average, the PASS-C® enhanced 2-hour sedimentation process removed 90 percent of the turbidity, 84 percent of the total phosphorus, 63 percent of the total nitrogen, 41 percent of the oil and grease, and 90 percent of the total iron from the influent. Under the controlled mixing conditions in the mechanized system runs, PASS-C® enhanced coagulation followed by sedimentation (CFS) was always able to produce an effluent compliant with the surface discharge limits. This suggests that with optimization, PASS-C® enhanced sedimentation may reliably produce effluent that complies with the surface water discharge limits.

5.3.4 Filter Loading Rate, 6-hour vs. Rapid Loading

All filters except one (35-F) were loaded slowly at 3 feet per six hours using a peristaltic pump to transfer water from the sedimentation tank to the filter. Filter Unit #35 was loaded with settled storm water from the sedimentation tank all at once, in a manner consistent with Phase I operation. The benefits of slow versus fast filter loading are assessed by comparing the results for Units 32-F (slow load) and 35-F (fast load) as shown in Figure 5-29. Both treatments included 2-hour sedimentation without chemicals and fine sand filtration with free-draining media.

As shown in Figure 5-29, slow filter application rates resulted in somewhat better performance than fast filter application rates. Slow loading of the filter resulted in higher turbidity, total phosphorus, total nitrogen and total iron removals. For oil and grease, the data are inadequate to make a definitive conclusion.

5.3.5 Free-Draining vs. Submerged Media Filters

Filters were tested with free draining and submerged media, as determined by the filter outlet piping (see the Monitoring and Operations Plan for a full description). Free-drain units simply have an outlet (1.5” PVC pipe) on the bottom of the filter tank to allow the media to drain without obstruction. Submerged media units have an outlet pipe that discharges at an elevation just above the filter media surface. This allows the media to remain submerged and causes the water to be uniformly distributed and filtered across the entire filter media area. The differences in filter performance due to free-draining and submerged media are illustrated in Figure 5-30. The top row of plots in Figure 5-30 is based on filtration after 2-hour sedimentation (Units 31-F and 36-F), while the bottom row is based on 24-hours sedimentation (Units 32-F and 33-F).

As shown in Figure 5-30, fine sand filters with submerged filter outlets had somewhat better removal of turbidity and total iron. For the other regulated parameters, there was little observable difference in performance.

5.3.6 Alternative Media Assessment

To assess the difference in filter performance due to the media itself, the results of the non-mechanized filters with fine sand (36-F), expanded shale (37-F), limestone (38-F), wollastonite (39-F), and activated alumina (40-F) media can be compared. Each of these filter units was tested following 24-hour, no-chemical sedimentation. All of the filters were slow-loaded (3 ft of settled storm water in 6 hours) and had submerged media. All 5 of the media filters were operated in all 6 experimental runs, except for the wollastonite media (38-F), which was operated for only the last two runs.

Table 5-5. Media Performance Based on Percent Removal and Concerns

Unit[1]	Media	Percent Removal[2]					Notes and Concerns
		Turb	Tot-P	Tot-N	O&G	Fe-T	
36-F	Fine Sand	66	34	10	100	66	Runs 9 and 10 had negative nitrogen removal percentages Generally ineffective, however no increase in effluent pH
37-F	Expanded Shale	99	82	79	76	100	Run 7 had a negative O&G removal (-43%) Concern with substantially elevated pH and dissolved aluminum in the effluent
38-F	Limestone	82	74	56	100	84	Concern with elevated pH levels the effluent Media requires substantial initial washing
39-F	Wollastonite	64	59	61	100	61	Insufficient data - wollastonite filter run 2 times only Some concern with elevated pH in the effluent
40-F	Activated Alumina	99	99	75	100	99	Run 10 had a negative tot-N removal (-6%). Without that value the percent removal = 92% Concern with elevated pH and dissolved aluminum in the effluent

[1] Filter Conditions – All filters followed 24-hour, no-chemical sedimentation and were slow loaded (3 ft in 6- hours) with the media submerged.

[2] Percent removals calculated for turbidity (Turb), total phosphorus (T-P), total nitrogen (T-N), oil and grease (O&G), and total iron (Fe-T)

Media performance can be evaluated by comparing contaminant removals. Percent removal values for the 5 regulated parameters (turbidity, total phosphorus, total nitrogen, oil and grease, and total iron) for each media are shown in Table 5-5. Some constituents were present in the influent storm water at levels below the requirements for surface water discharge in the Tahoe Basin; however, as long as the constituent was present above

detection limit (all cases except for some oil and grease), a percent removal value can be calculated. It should be noted that media performance with respect to the ability to remove the regulated constituents should not be the only criteria used for evaluation. Treatment "side effects", such as increases in pH and/or dissolved aluminum should be considered before final media selection. Some concerns related to media "side effects" are listed in Table 5-5.

The expanded shale and the activated alumina media had the highest removal percentages for turbidity, total phosphorus, total nitrogen and iron total. Although only 3 of 6 experimental runs contained measurable oil and grease, most media were consistently able to remove it. Only the expanded shale filter effluent in Run 7 had any measurable oil and grease, and this was likely an anomaly (effluent was measured to be greater than the influent being tested, 15 mg/L versus 10.5 mg/L in the influent). Several of the media increased the pH of the effluent, some more than others (expanded shale). Several of the media require extensive initial rinsing (limestone and to a lesser extent, activated alumina). Based strictly on removal percentages, the activated alumina media performed the best.

5.3.7 Proprietary vs. Non-Proprietary Mechanized Treatment Systems

Both the proprietary and non-proprietary mechanized systems tested were effective in meeting the surface water discharge limits for all of the parameters in all 6 experimental runs. The differences between the proprietary (Actiflo®) system and the conventional coagulation, flocculation and sedimentation process include the absence of the ballast sand in the conventional system, and differences in the mixer speed and time sequence used for rapid mixing, maturation and settling of the floc particles. The time required to process a single batch of storm water using the Actiflo® system was about 10 minutes, including settling time. The time required to process a single batch of storm water using the conventional system, including settling time, was about 45 minutes. After batch Actiflo® processing, the effluent was polished using a proprietary Fuzzy Filter® and ion exchange columns (cation and anion). For the non-proprietary system, effluent from the conventional coagulation, flocculation, and sedimentation unit was polished through a pressure sand filter (non-proprietary) and then through the ion exchange units.

Batch Coagulation/Flocculation/Sedimentation Process: Graphs comparing the performance of the Actiflo® versus the non-proprietary "conventional" flocculation and sedimentation (floc/sed) system are presented in the top row of Figure 5-31. The proprietary floc/sed unit (Actiflo®) performed somewhat better than the conventional unit on turbidity and total iron removal. Treatment performance for the other regulated parameters (total phosphorus, total nitrogen and oil and grease) was similar. Effluent from both proprietary and non-proprietary systems always met the permit limits after the first unit process (Actiflo® or conventional coagulation, flocculation, and sedimentation).

Polishing Filters: Because of the removal of much of the solids and other contaminants in the batch flocculation/sedimentation processes (either Actiflo® or the conventional floc/sed process), evaluation of the effectiveness of the subsequent polishing filters (pressure sand filter or Fuzzy Filter®) is not conclusive. The second row of graphs in Figure 5-31 shows the performance of the Actiflo® + Fuzzy Filter® train versus the conventional floc/sed + pressure sand filter treatment train. From these plots, it appears that the Actiflo® + Fuzzy Filter® train

performed slightly better than the conventional floc/sed + pressure sand filter for iron, and turbidity removal. Elevated iron in the pressure sand filter effluent may be due to internal rusting in the iron filter vessel or an accumulation (and subsequent release) of material within the filter, since the sand media had not been backwashed during any of the 12 experimental runs (Phase I nor Phase II). From the graph in Figure 5-31 in which most of data the points fall below the 45-degree line, the non-proprietary conventional floc/sed + pressure sand filter train may have performed slightly better on total nitrogen removal. Performance on the other regulated parameters was similar.

The influent to the Fuzzy Filter® was not untreated storm water but rather batch Actiflo® effluent. Similarly, the influent to the pressured sand filter was the effluent from the batch flocculation/sedimentation process. Graphs of influent versus effluent concentration for turbidity and total-nitrogen are presented in Figure 5-32 for the two polishing filters.

From the turbidity graph (Figure 5-32), the influent to the pressure sand filter often (4 of 6 runs) contained more turbidity than the influent to the Fuzzy Filter®; however, the effluent turbidity was generally about the same. Considering this, the pressure sand filter demonstrated equivalent performance at a wider operating range.

From the total-nitrogen graph (Figure 5-32), the influent and effluent filter values are evenly mixed, with nearly and equal number of data points above and below the bisecting line (line of equal treatment) and generally trend along the line with some proximity. This indicates that the total nitrogen fraction in the influent to the filters (effluent from either the Actiflo® or the conventional flocculation/sedimentation run) contained primarily dissolved nitrogen, or particulate nitrogen having a particle size below the filters retention capability.

To reiterate, both treatment trains (Actiflo® + Fuzzy Filter® or conventional floc/sed + pressure sand filter) always met the permit limits for all parameters. Of particular note is that the Fuzzy Filter® was always operated in Phase II with new (or newly cleaned) media. Based on fouling observations made in Phase I, a regime of cleaning and servicing is required to maintain Fuzzy Filter® performance with intermittent operation. This is an important consideration when selecting a polishing filtration process for actual field applications. The main benefit of the Fuzzy Filter, however, is that it can be operated at hydraulic loading rates about six times that of a pressure sand filter, making it about one-sixth the size (based on area).

Ion Exchange: The performance of ion exchange units following the proprietary and non-proprietary treatment trains was similar, again, easily meeting all permit limits (Figure 5-31, last row of plots). The ion exchange units reduced the total nitrogen levels somewhat and removed traces of iron from the effluent of the pressure sand filter.

Overall the performance of the proprietary and non-proprietary mechanized systems was quite similar. The proprietary treatment train was able to remove 100% of the turbidity, 83% of the total phosphorus, 79% of the total nitrogen, 100% of the oil and grease and 100% of the total iron on an average basis over the 6 experimental runs. Similarly, the conventional mechanized treatment train removed 100% of the turbidity, 90% of the total phosphorus, 80% of the total nitrogen, 100% of the oil and grease and 100% of the total iron on an average basis over the 6 experimental runs. In making these assessments, 100% removal means that effluent values were below the reporting limit.

5.3.8 Non-Mechanized vs. Mechanized Systems

The mechanized systems have shown a greater potential for consistently producing an effluent that is compliant with the surface water discharge requirements within the Tahoe Basin. The Actiflo® process and conventional coagulation, flocculation and sedimentation steps removed most of the contaminants and met all discharge limits. The Fuzzy Filter®, pressure sand filter, and ion exchange units contributed a little more contaminant removal, but were not needed to meet the numerical permit requirements for surface discharge.

The non-mechanized systems that appear promising with regard to meeting discharge limits for surface water discharge include the following:

1. Fine sand filtration following sedimentation with PASS-C®.
2. Filtration through activated alumina following sedimentation without chemicals, if the high effluent pH and aluminum leaching can be mitigated.
3. Filtration through expanded shale following sedimentation without chemicals, if the high effluent pH and aluminum leaching can be mitigated.

Using the average percent removal of the 5 regulated parameters as a tool to compare overall process effectiveness, the proprietary and non-proprietary mechanized systems score a 92 and 94, respectively. Fine sand filtration following 2-hour sedimentation with PASS-C® scored an 88 (average of the 5 parameter percent removals). Note that with PASS-C® addition, the potential for low pH (<6.5) exists. The expanded shale and activated alumina filter media (following 24-hour sedimentation) scored an 87 and 94, respectively. Note that the use of these two media may result in elevated pH and aluminum levels in the effluent for an unknown length of time.

Although the non-mechanized activated alumina filter (40-F) had the highest overall average percent removal, the effluent meet the surface water discharge standards 28 out of 30 times; whereas both of the mechanized treatment trains met the surface water discharge standards 30 out of 30 times. Sand filtration following 2-hour sedimentation with PASS-C® complied with the limits 30 out of 30 times. Therefore, the mechanical and chemical addition systems (which require considerable operator attention and electrical requirements) may provide the most consistent level of acceptable treatment with respect to meeting the surface water discharge limits within the Tahoe Basin.

5.3.9 Phase II vs. Phase I

The influent storm water used in Phase II, on average, contained lower concentrations of most of the regulated constituents than in Phase I. Average turbidity in the Phase I storm water used was 539 NTU (6 run average), compared to the Phase II average of 301 NTU. Average total nitrogen in the Phase I influent was 2.6 mg-N/L, while the Phase II influent averaged only 0.89 mg-N/L. Average total phosphorus in the Phase I influent was 0.80 mg-P/L. Average total phosphorus in the Phase II influent storm water was 0.52 mg-P/L. Phase I and Phase II oil and grease, iron and aluminum influent averages were similar. Average electrical conductivity was 971 µmhos/cm in Phase I and 516 µmhos/cm in Phase II,

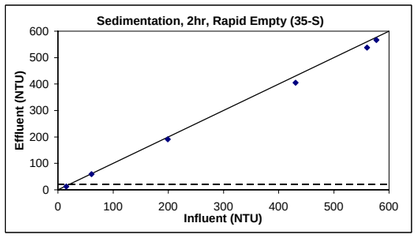
perhaps indicating that less road salt was present in the storm water batches collected during Phase II.

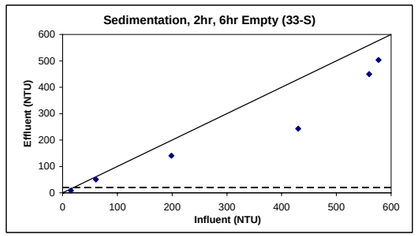
Similar to Phase I, chemical addition during sedimentation greatly increased contaminant removal. In both project phases, sedimentation without chemical addition was ineffective at removing contaminants below the surface water discharge standards. The addition of fine sand filtration after chemical addition (with PASS-C®) and sedimentation was also effective in both project phases.

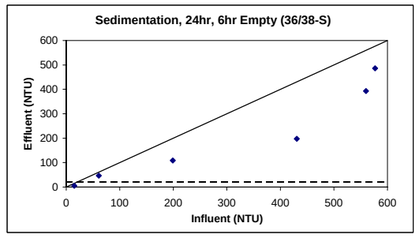
Activated alumina filter media was tested in Phase I, but the conditions of use were quite different than in Phase II. In Phase I, activated alumina filters were fast-loaded and free draining and were tested both without prior sedimentation and with 2-hour sedimentation with PASS-C®. In Phase II, activated alumina was tested after 24-hour sedimentation without chemicals, and with slow loaded, submerged media. Therefore, direct comparisons between Phase I and Phase II results for activated alumina are not appropriate.

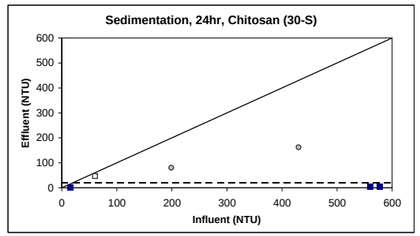
For the mechanized systems, the conventional coagulation, flocculation, and sedimentation treatment process and Actiflo®, both with optimized chemical dosing, performed as well as Actiflo® performed in Phase I with fixed chemical dosing. An observed difference was the mechanized systems were able to meet nitrogen regulatory limits for surface waters in Phase II, but not in Phase I. However, this was probably due to much lower influent total nitrogen concentrations in Phase II, compared to Phase I.

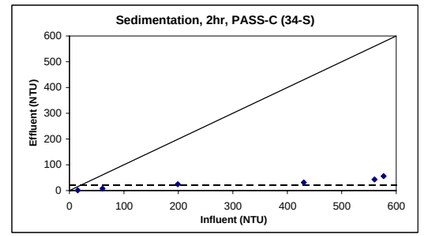
Turbidity

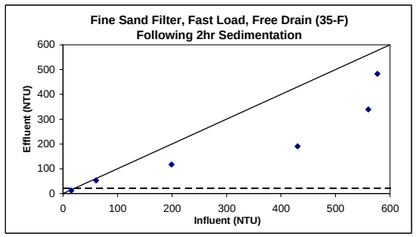


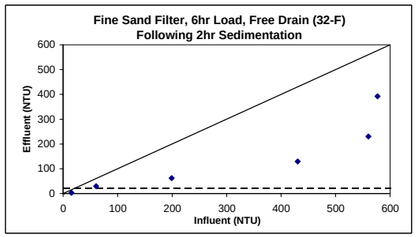


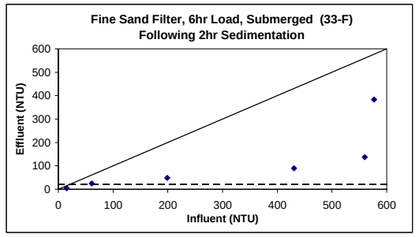


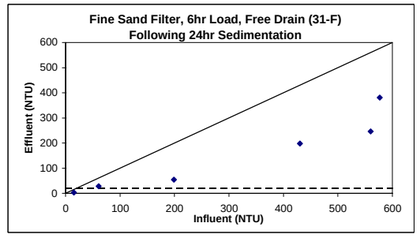


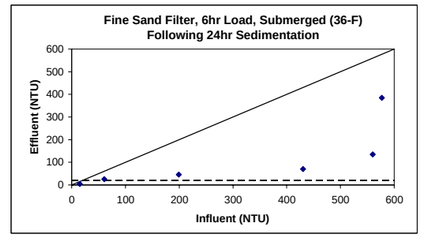


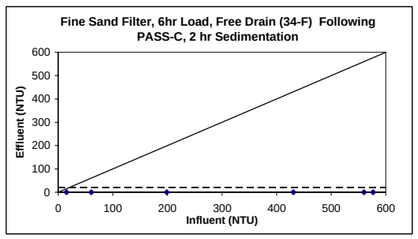


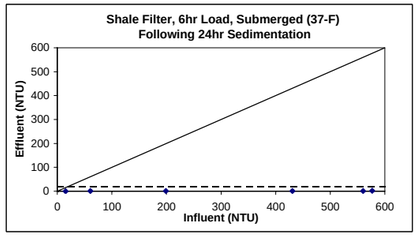


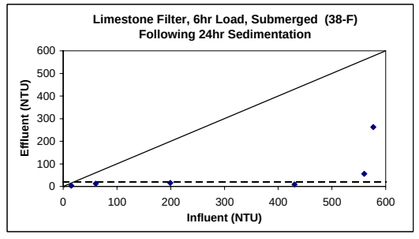


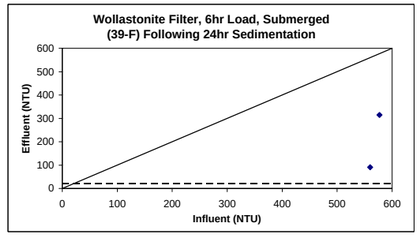


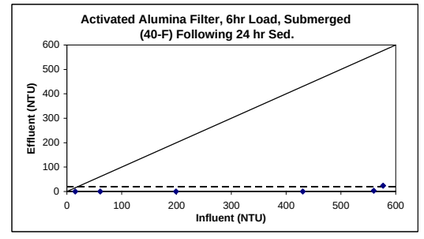


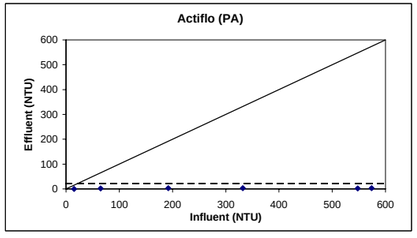


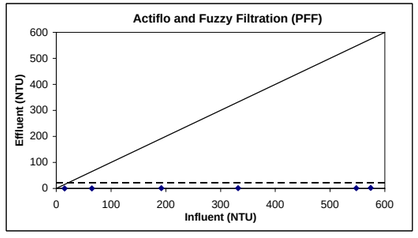


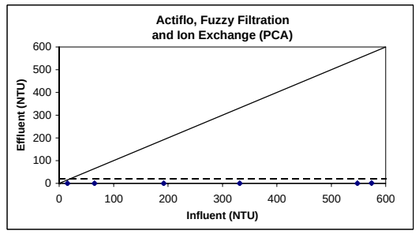












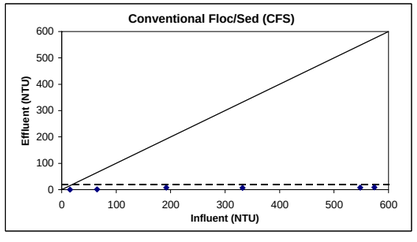
GENERAL LEGEND

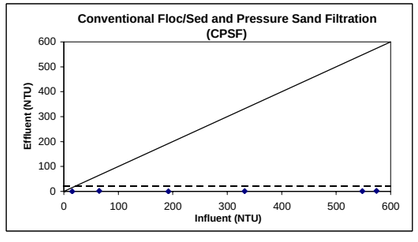
Sample Points (influent, effluent)

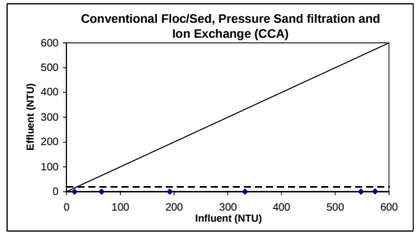
1 to 1 Influent to effluent sample concentration line - If the sample point is below this line, the concentration decreased through the treatment process. If the sample point falls above this line, the concentration increased through the treatment process.

Maximum Lake Tahoe Basin surface water discharge for Turbidity = 20 NTU

Analytical reporting limit line - If sample points fall on these lines, the sample result was equal to the laboratory reporting limit (<0.1 NTU, Not Visible).







LEGEND FOR CHITOSAN SEDIMENTATION (30-S)

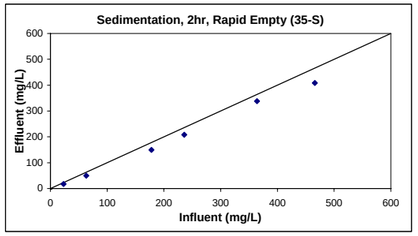
- Dose = 1 mg/L
- Eff Reg
- Report Limit Y
- Report Limit X
- Dose = 0.5 mg/L
- Dose = Passive

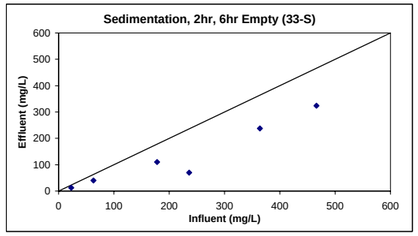
NOTES

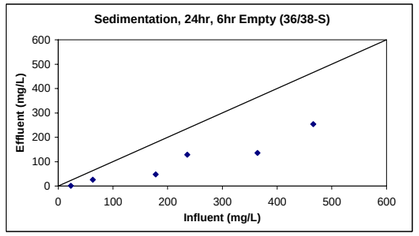
* All turbidity values measured in the field.

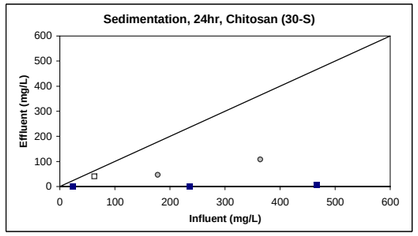
Figure 5-1. Turbidity

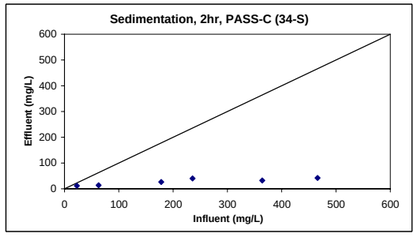
Total Suspended Solids (TSS)

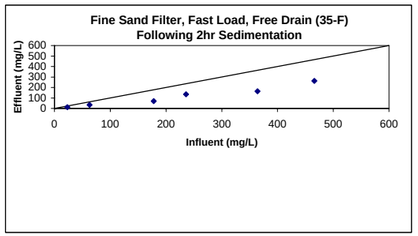


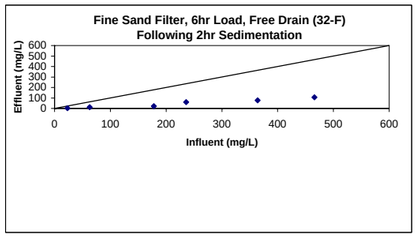


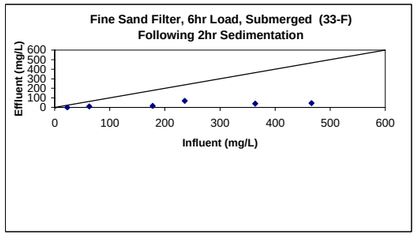


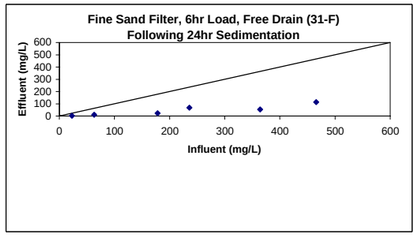


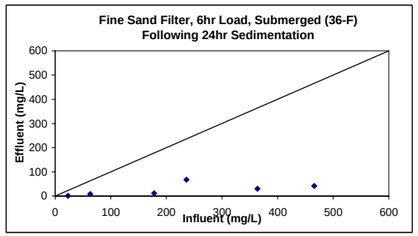


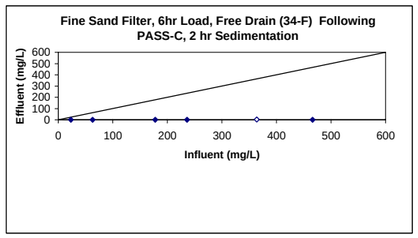


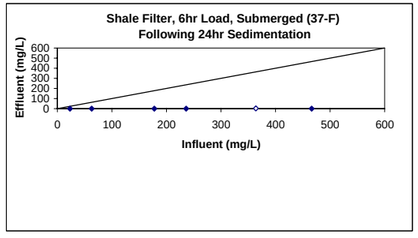


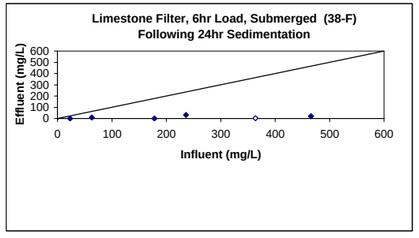


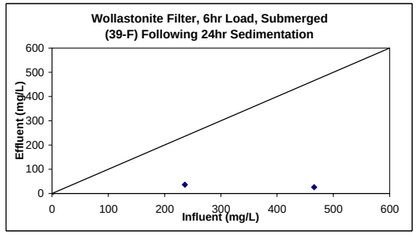


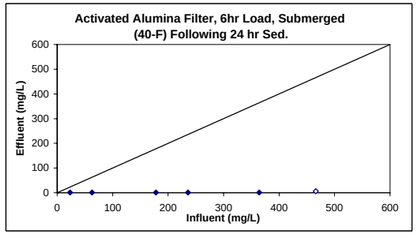


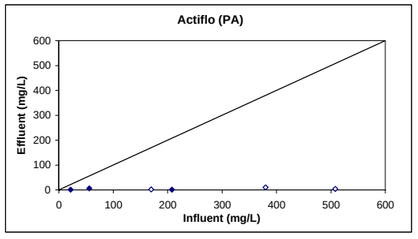


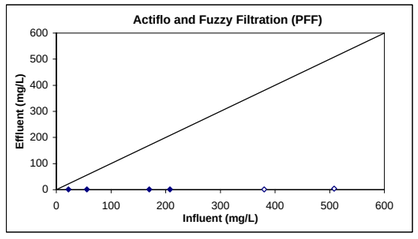


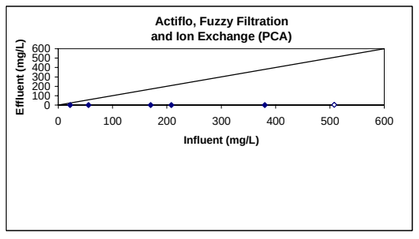


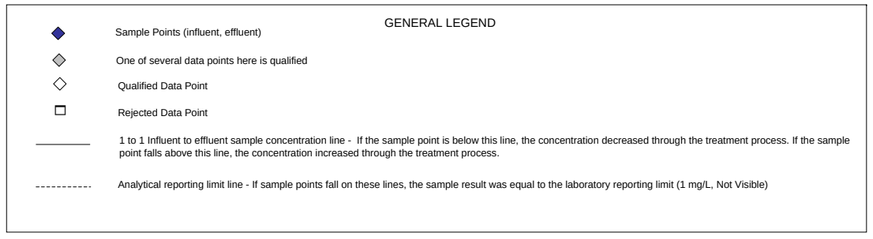


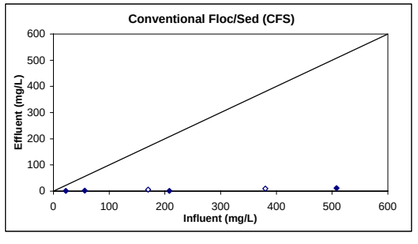


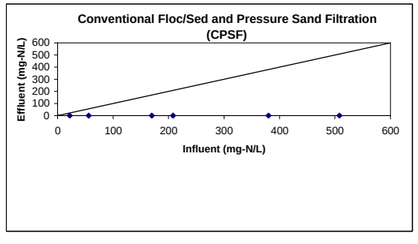


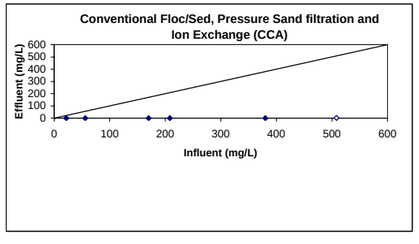


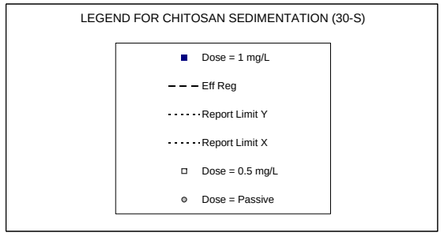












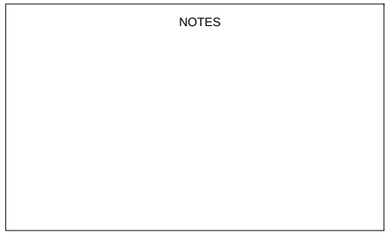
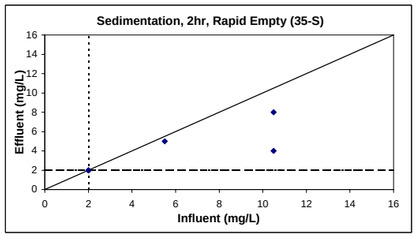
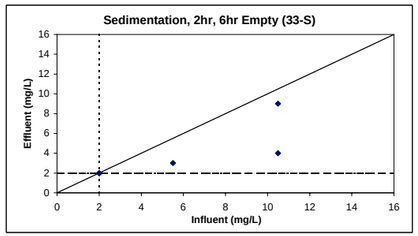
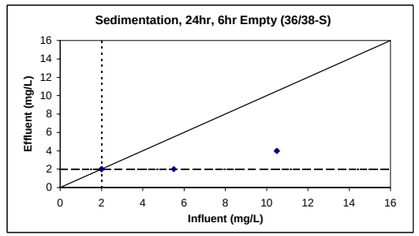


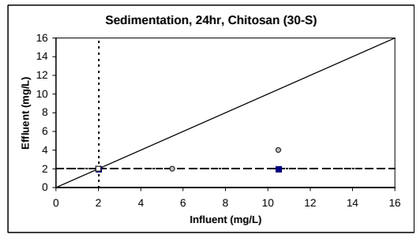
Figure 5-2. Total Suspended Solids

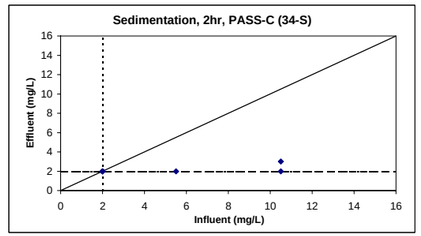
Oil and Grease

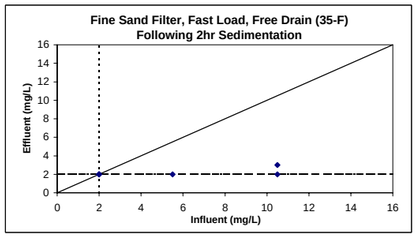


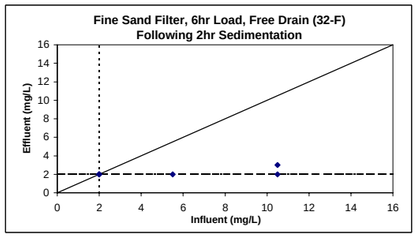


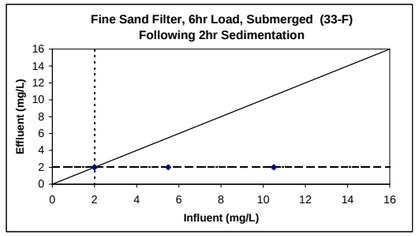


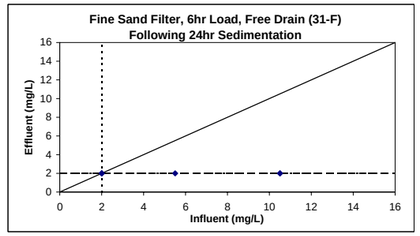


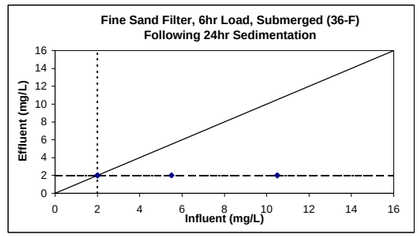


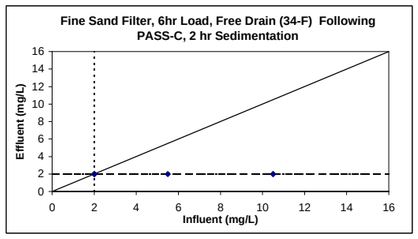


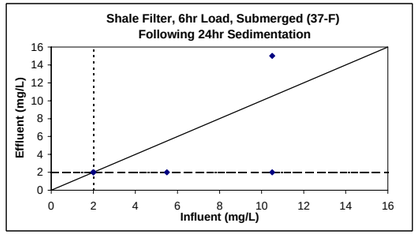


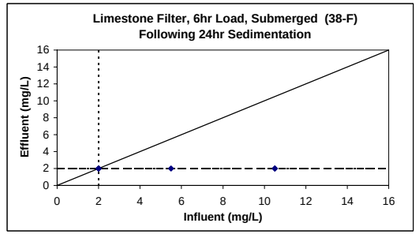


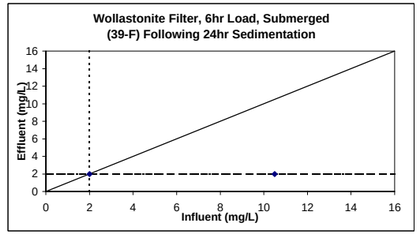


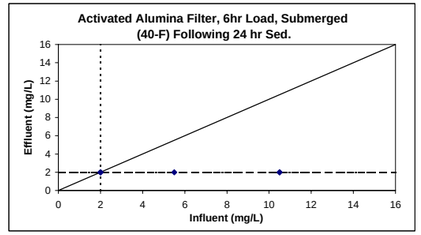


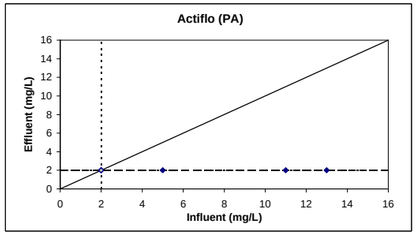


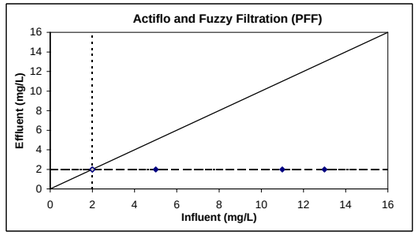


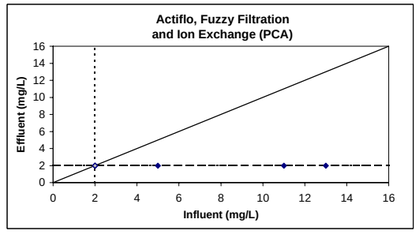


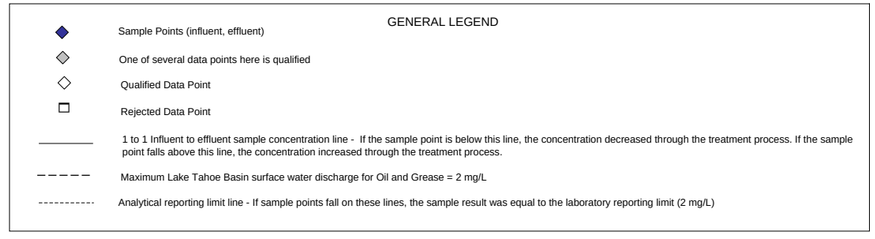


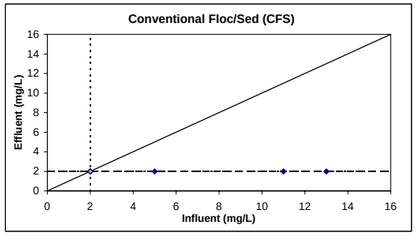


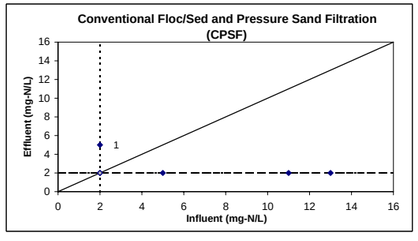


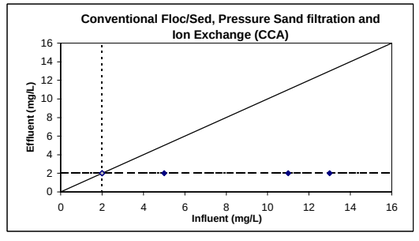


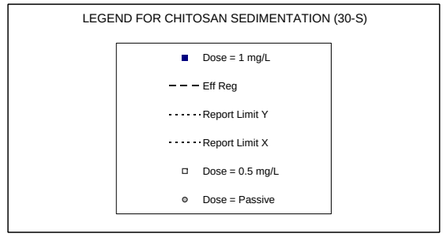












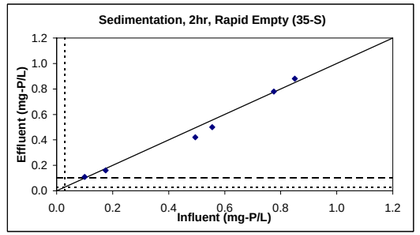
NOTES

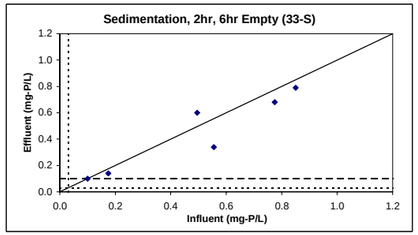
* 1 Detection limit = <5 mg/L (Lab loss, broken bottle)

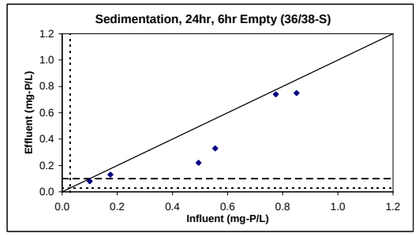
* All treatment plots have 6 data points, with the exception of the Wollastonite filter (39-F) which has 2. There are multiple points located at (<2, <2) and (11,<2)

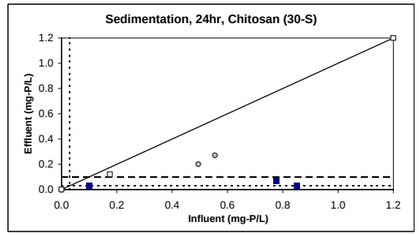
Figure 5-3. Oil and Grease

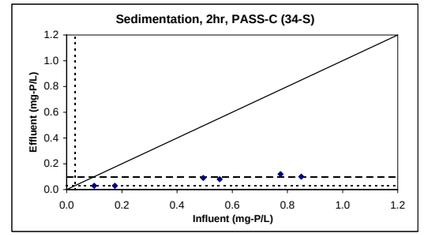
Phosphorus - Total

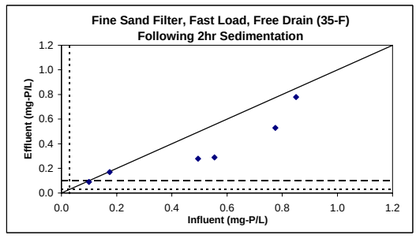


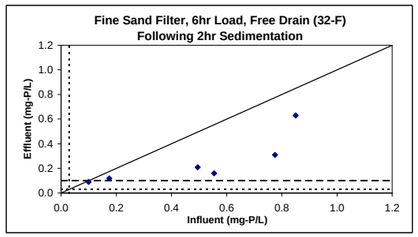


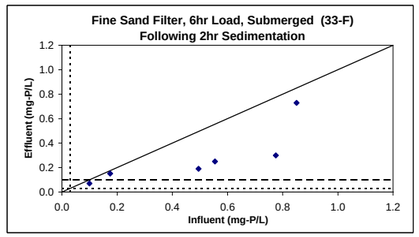


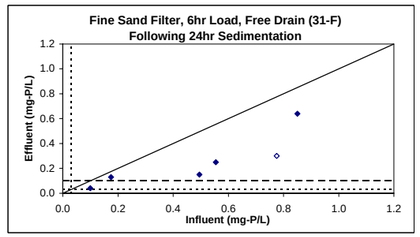


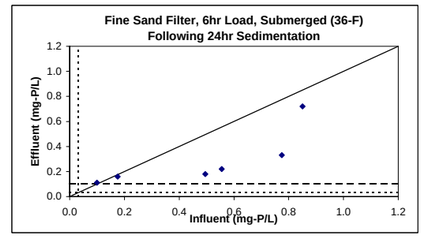


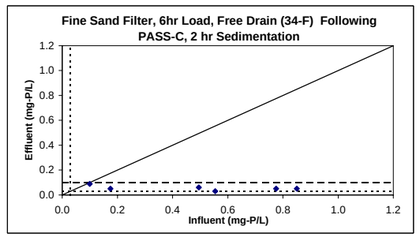


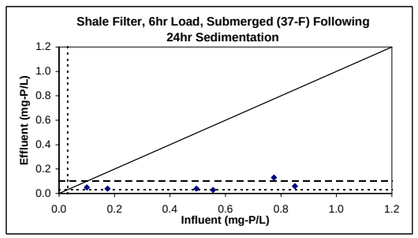


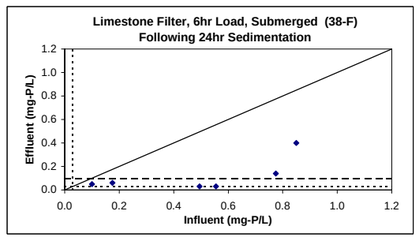


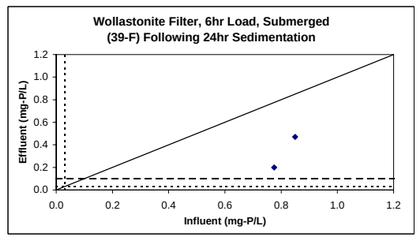


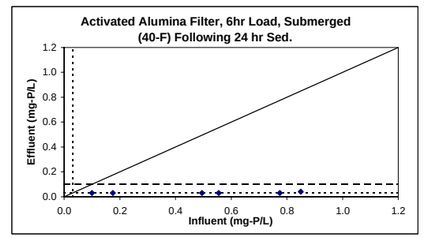


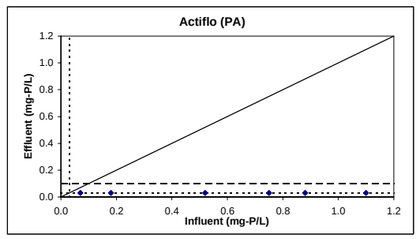


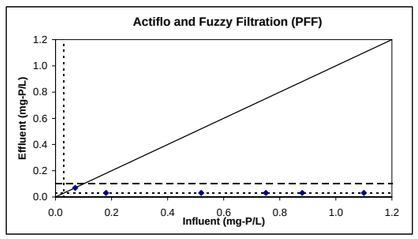


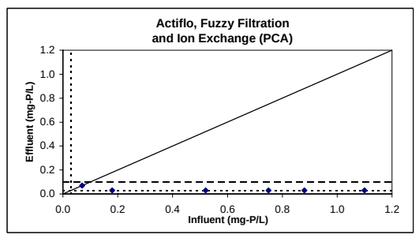


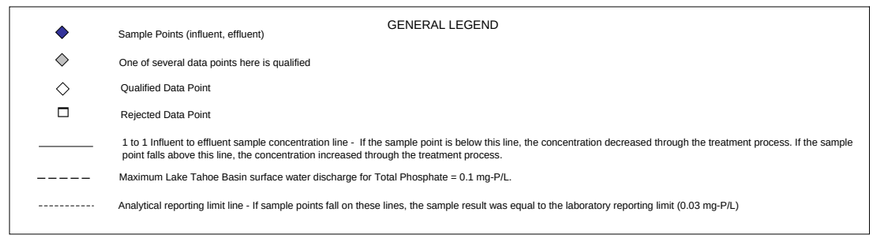


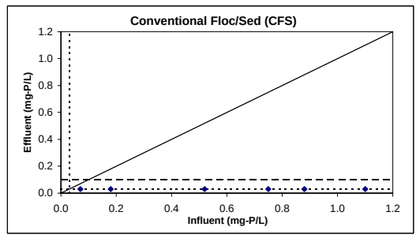


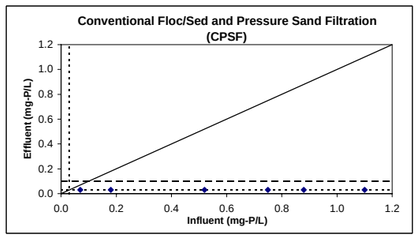


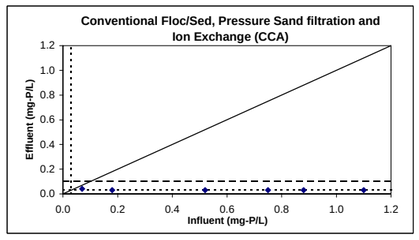


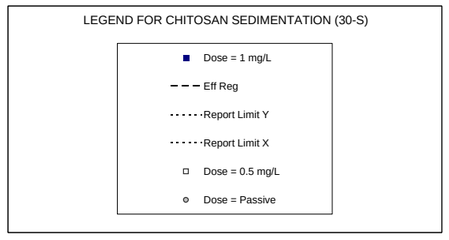












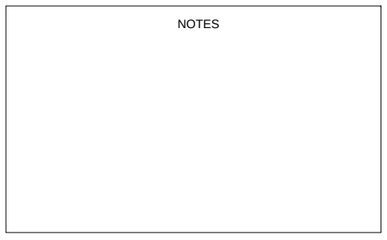
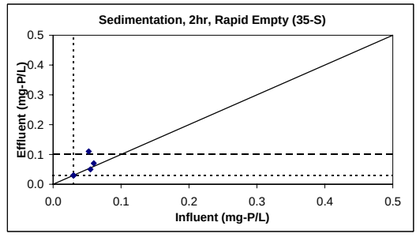
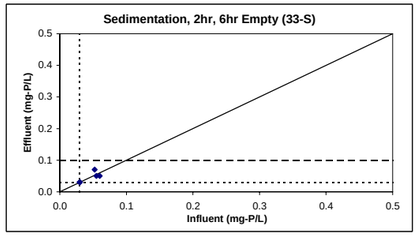
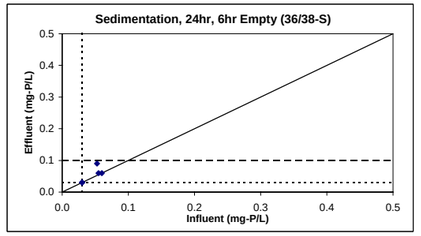


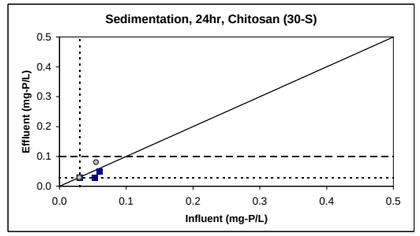
Figure 5-4. Phosphorus - Total

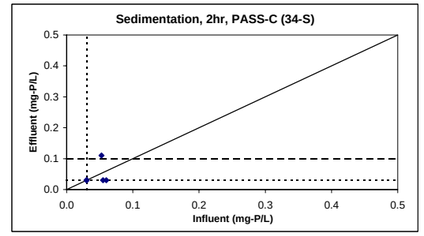
Phosphorus - Dissolved

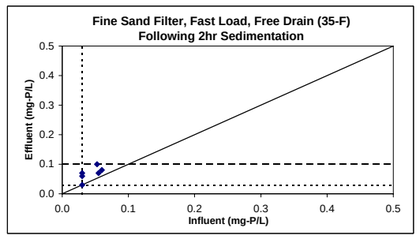


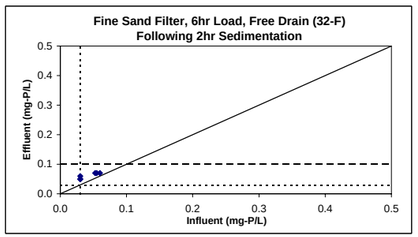


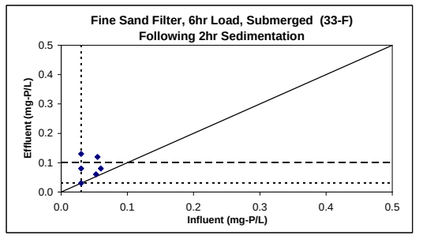


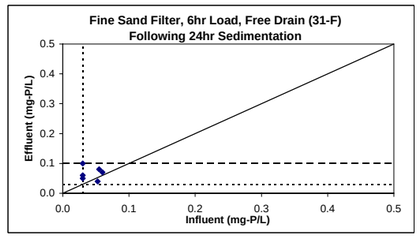


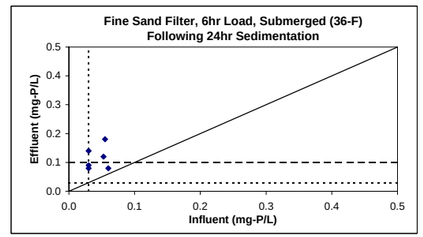


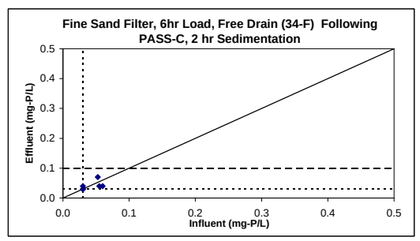


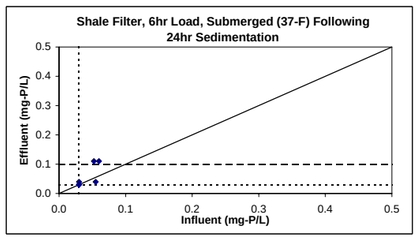


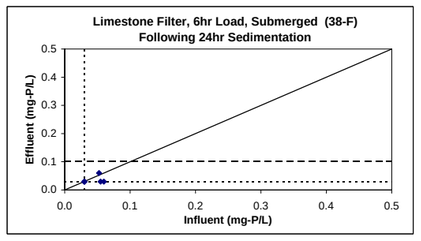


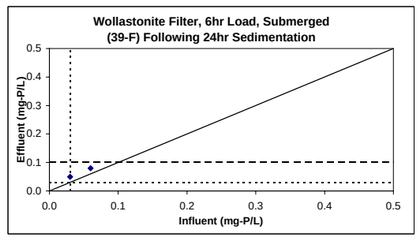


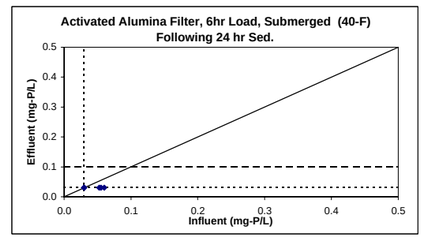


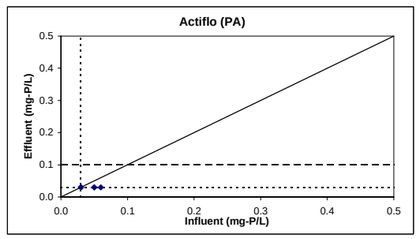


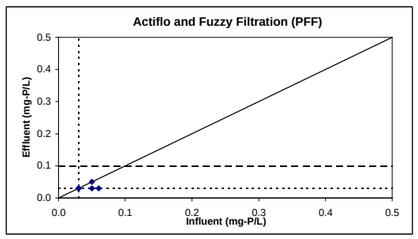


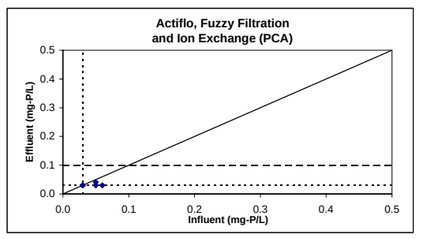


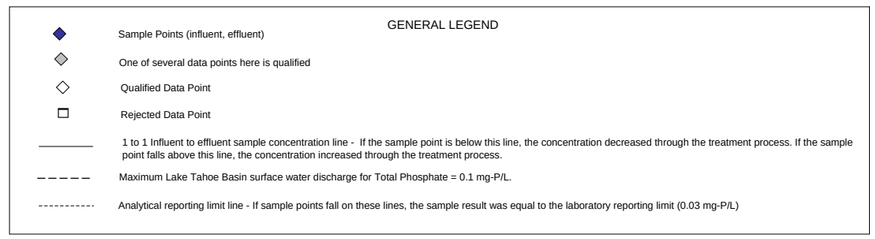


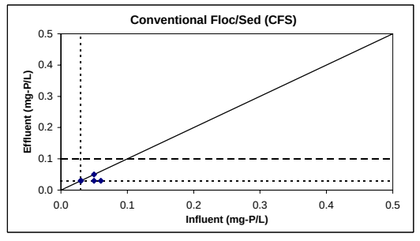


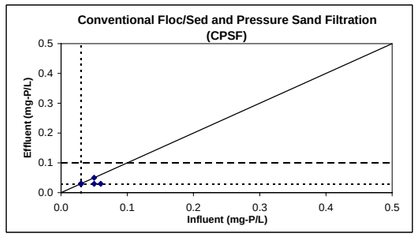


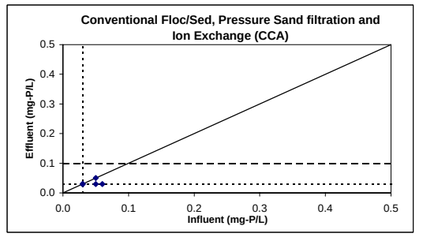


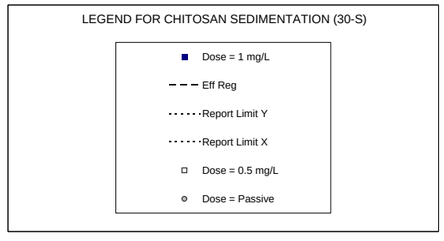










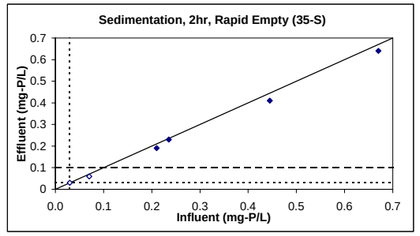


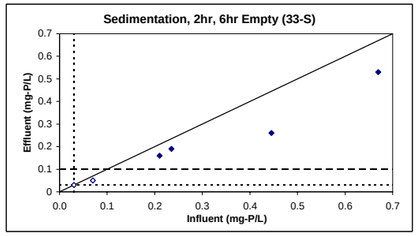
NOTES

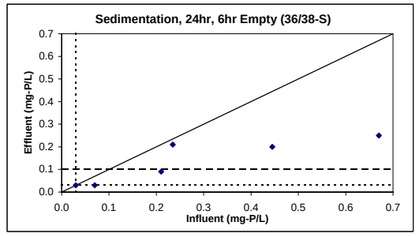
* All treatment plots have 6 data points, with the exception of the Wollastonite filter (39-F) which has 2. There are multiple points locate at (<0.03, <0.03)

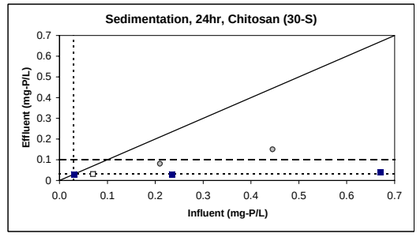
Figure 5-5. Phosphorus - Dissolved

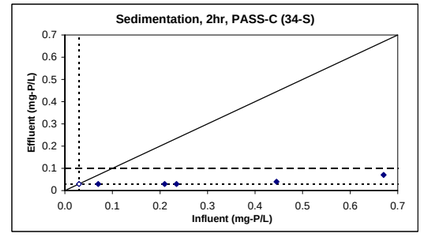
Phosphorus - Orthophosphate - Total

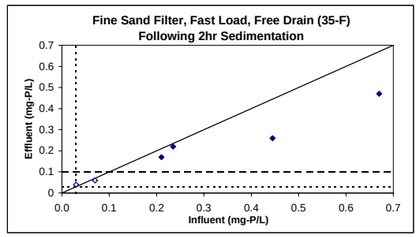


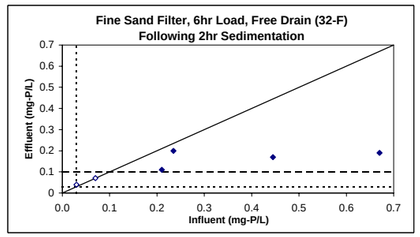


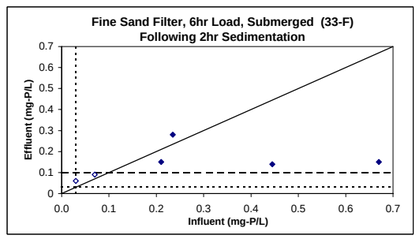


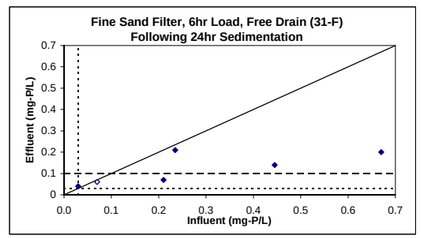


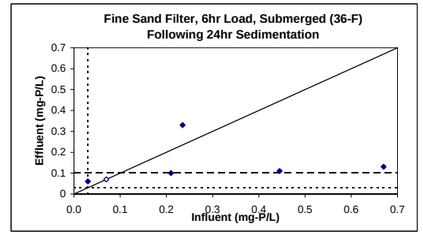


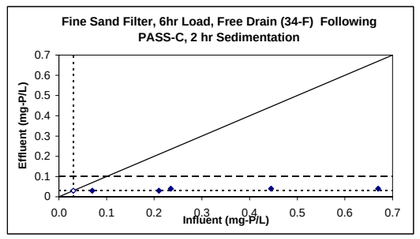


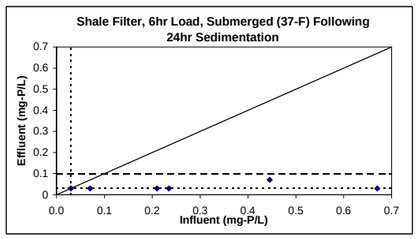


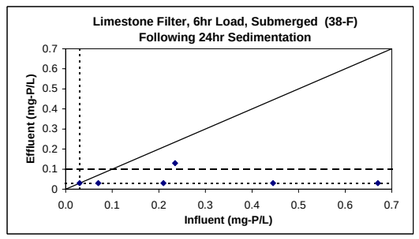


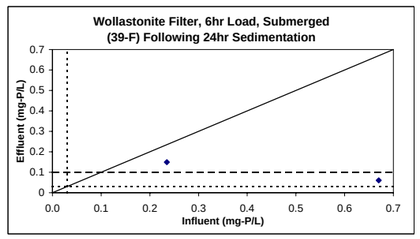


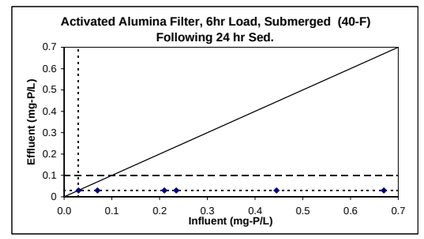


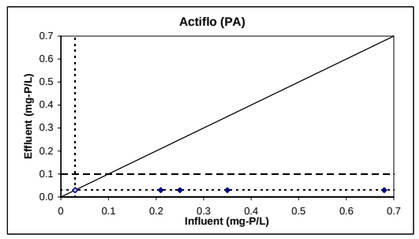


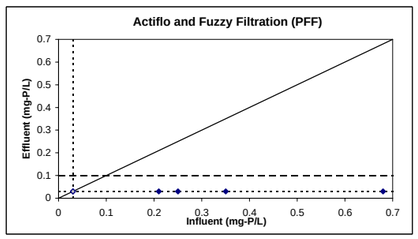


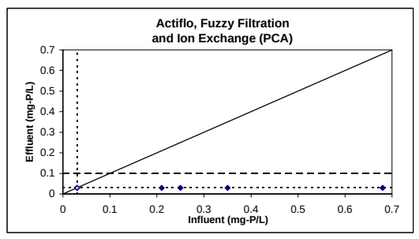






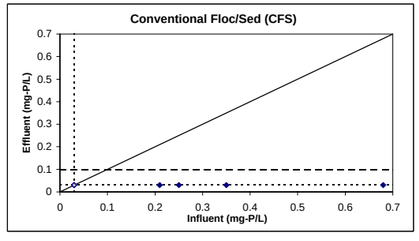


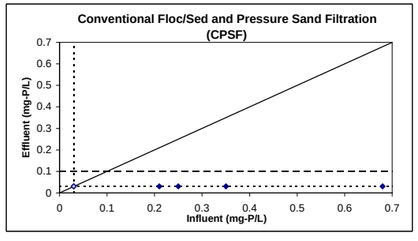


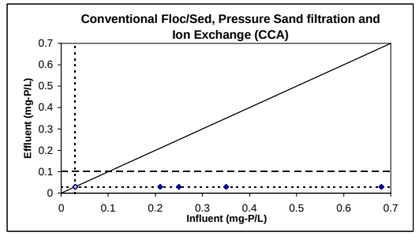


GENERAL LEGEND

- Sample Points (influent, effluent)
- One of several data points here is qualified
- Qualified Data Point
- Rejected Data Point
- 1 to 1 Influent to effluent sample concentration line - If the sample point is below this line, the concentration decreased through the treatment process. If the sample point falls above this line, the concentration increased through the treatment process.
- Maximum Lake Tahoe Basin surface water discharge for Total Phosphate = 0.1 mg-P/L.
- Analytical reporting limit line - If sample points fall on these lines, the sample result was equal to the laboratory reporting limit (0.03 mg-P/L)







LEGEND FOR CHITOSAN SEDIMENTATION (30-S)

- Dose = 1 mg/L
- Eff Reg
- Report Limit Y
- Report Limit X
- Dose = 0.5 mg/L
- Dose = Passive

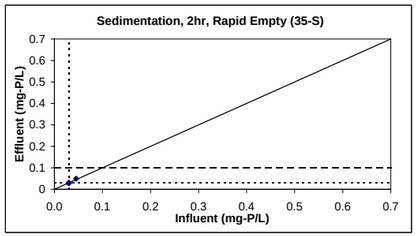
NOTES

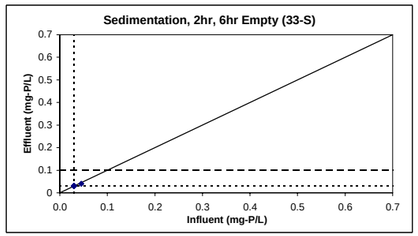
* All treatment plots have 6 data points, with the exception of the Wollastonite filter (39-F) which has 2.

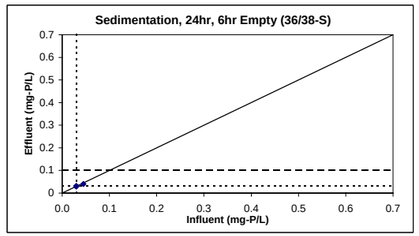
* Mechanized system plots have two points located at (<0.03, <0.03).

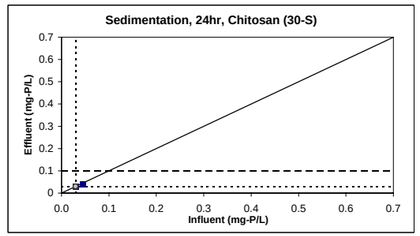
Figure 5-6. Phosphorus - Orthophosphate - Total

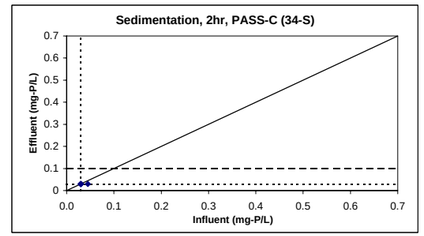
Phosphorus - Orthophosphate - Dissolved

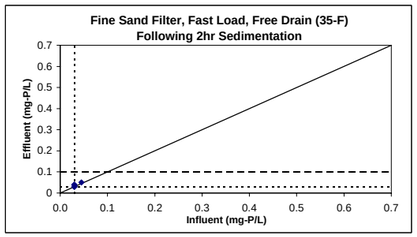


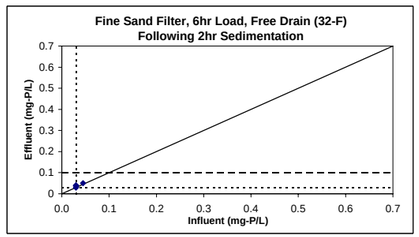


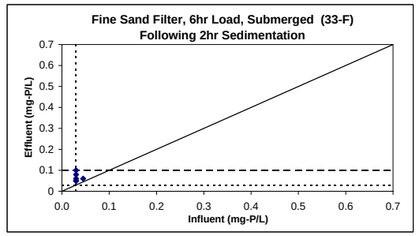


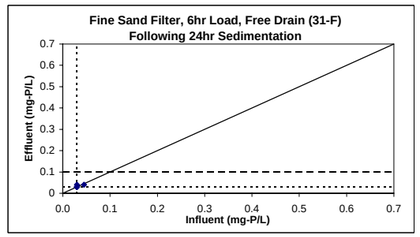


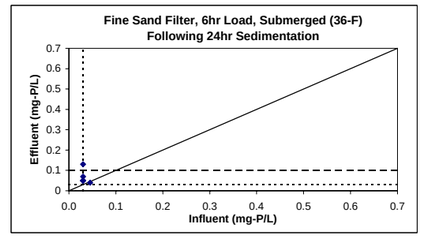


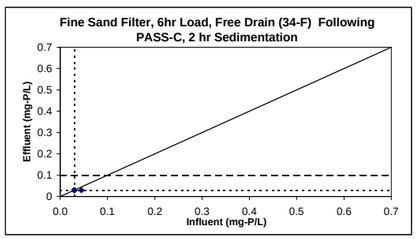


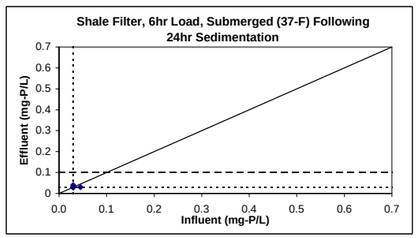


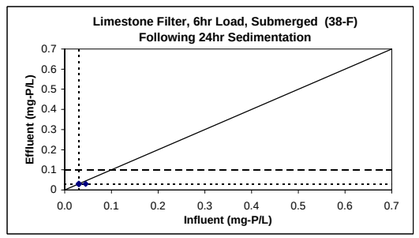


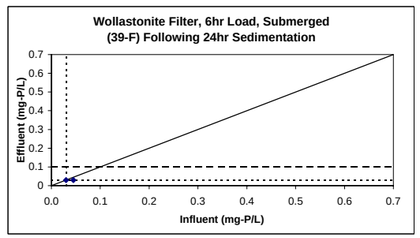


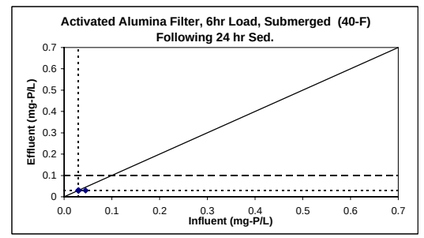


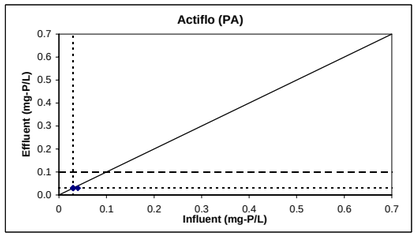


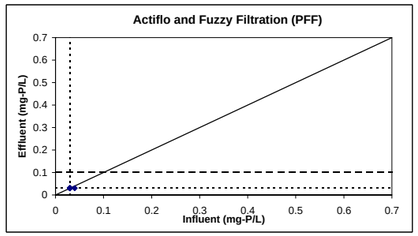


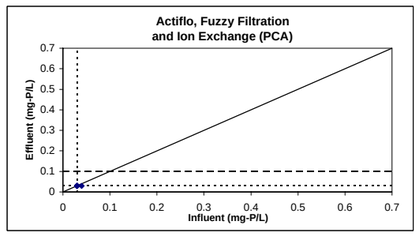






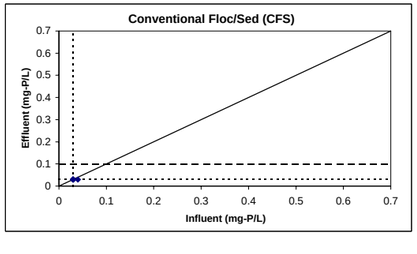


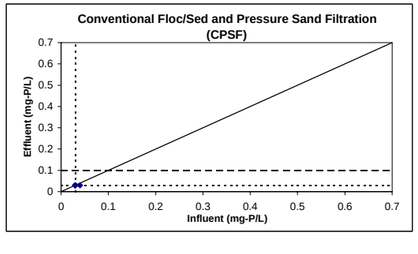


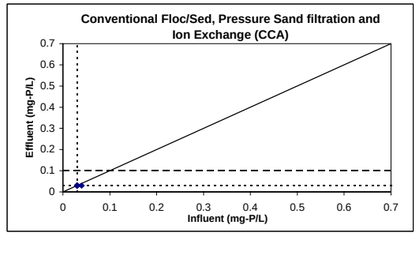


GENERAL LEGEND

- Sample Points (influent, effluent)
- One of several data points here is qualified
- Qualified Data Point
- Rejected Data Point
- 1 to 1 Influent to effluent sample concentration line - If the sample point is below this line, the concentration decreased through the treatment process. If the sample point falls above this line, the concentration increased through the treatment process.
- Maximum Lake Tahoe Basin surface water discharge for Total Phosphate = 0.1 mg-P/L.
- Analytical reporting limit line - If sample points fall on these lines, the sample result was equal to the laboratory reporting limit (0.03 mg-P/L)







LEGEND FOR CHITOSAN SEDIMENTATION (30-S)

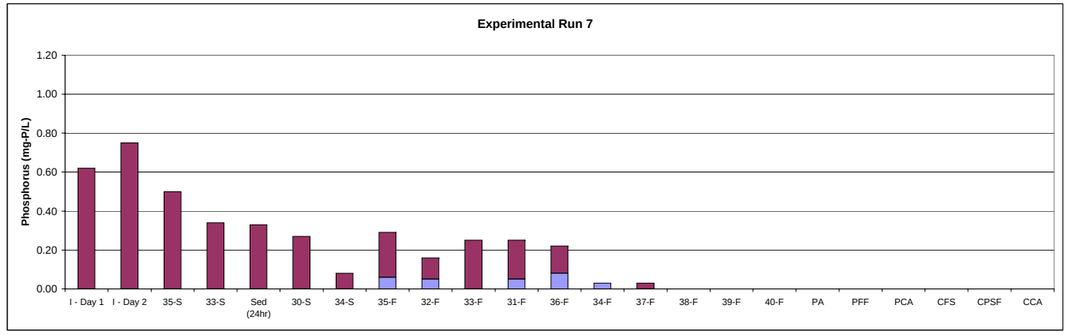
- Dose = 1 mg/L
- Eff Reg
- Report Limit Y
- Report Limit X
- Dose = 0.5 mg/L
- Dose = Passive

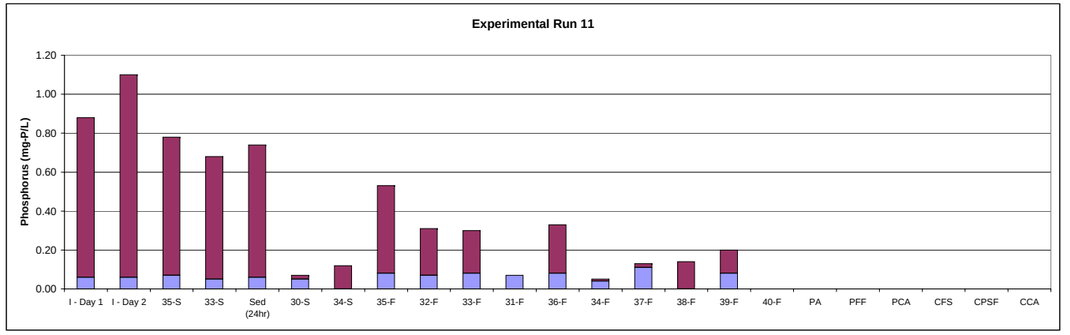
NOTES

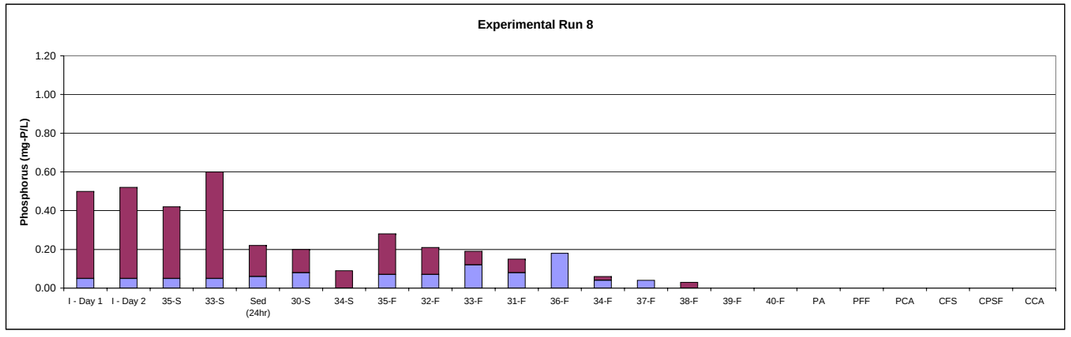
* All treatment plots have 6 data points, with the exception of the Wollastonite filter (39-F) which has 2. There are multiple points located at (<0.03, <0.03)

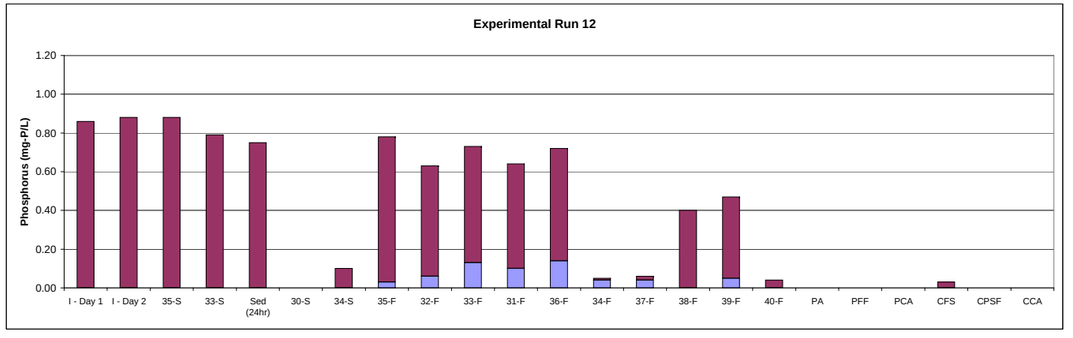
Figure 5-7. Phosphorus - Orthophosphate - Dissolved

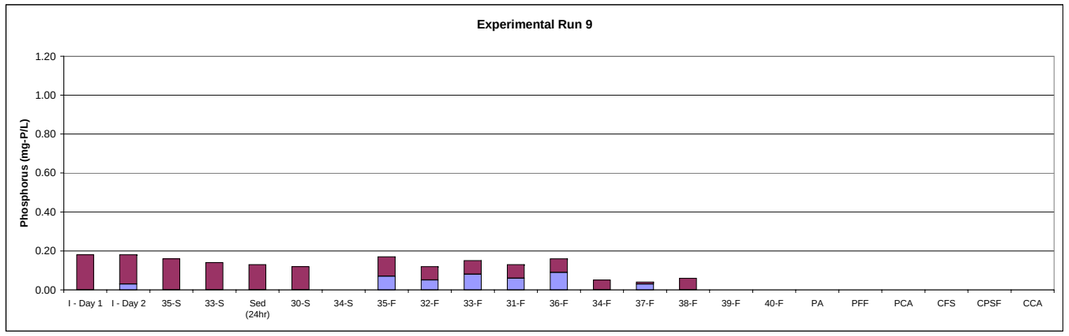
Forms of Phosphorus - Before and After Treatment

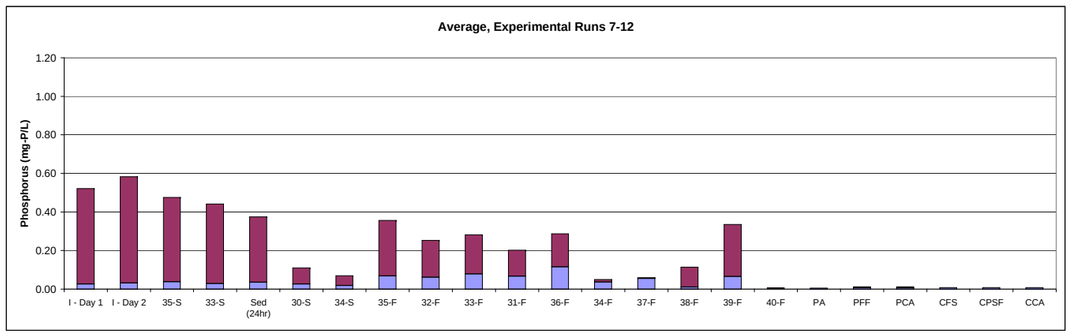


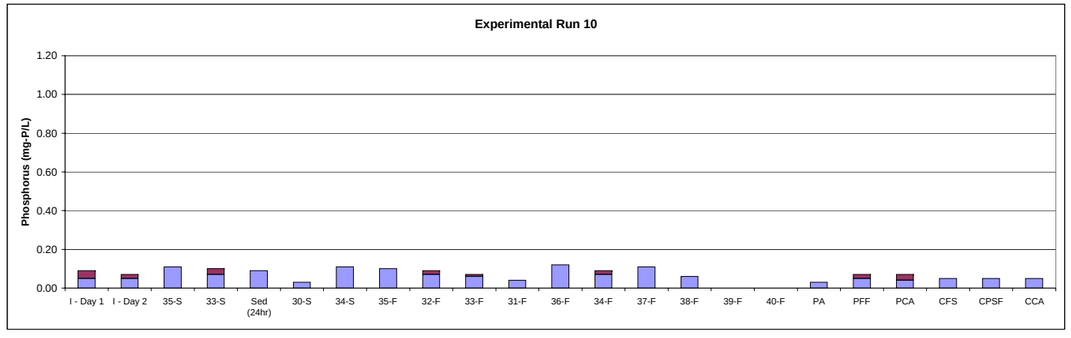












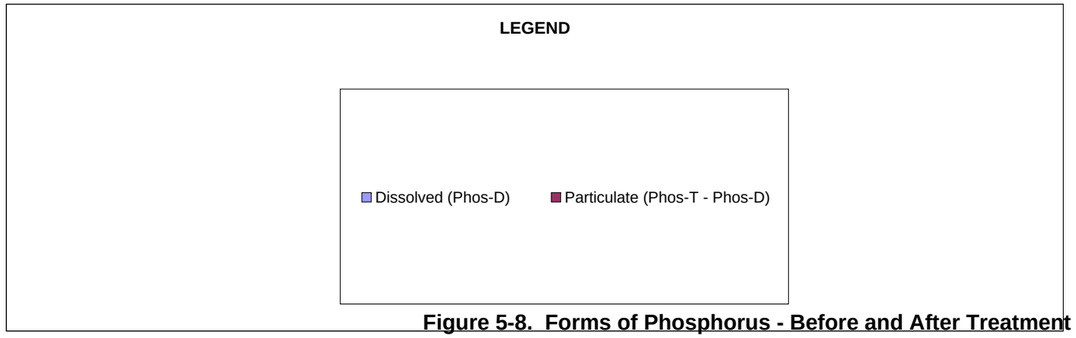
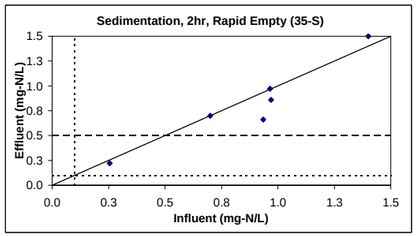
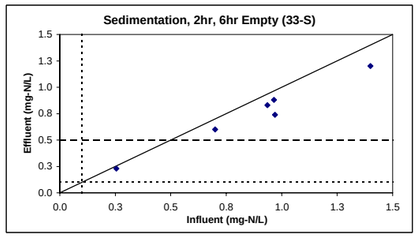
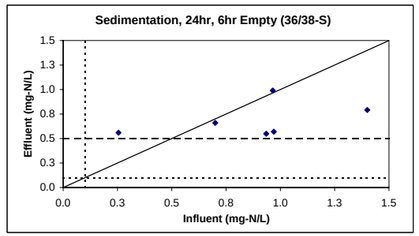


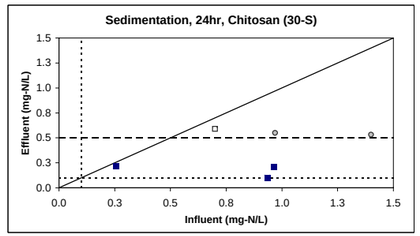
Figure 5-8. Forms of Phosphorus - Before and After Treatment

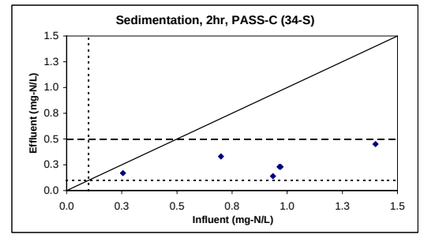
Nitrogen - Total

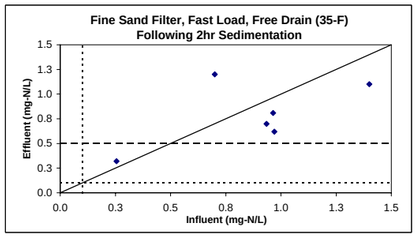


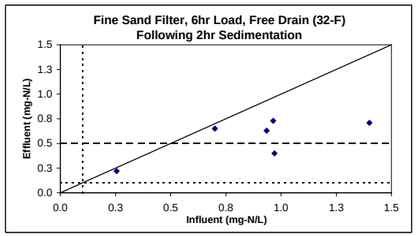


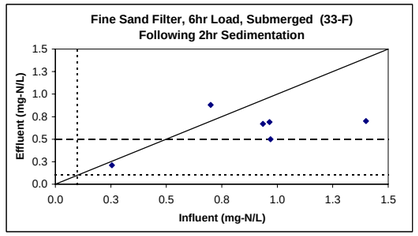


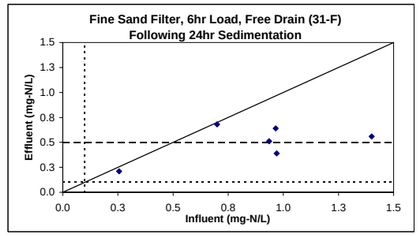


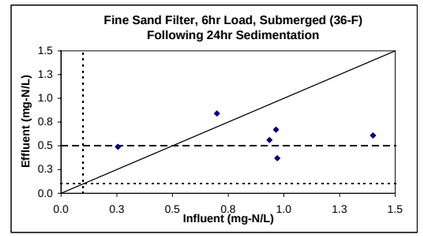


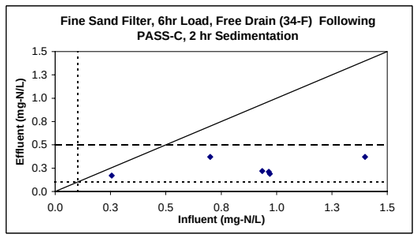


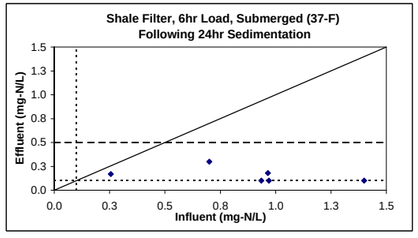


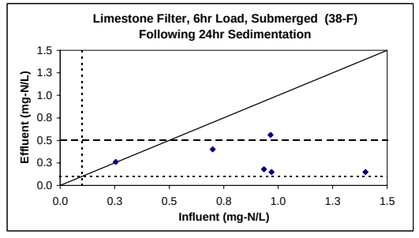


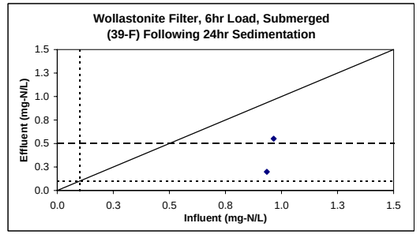


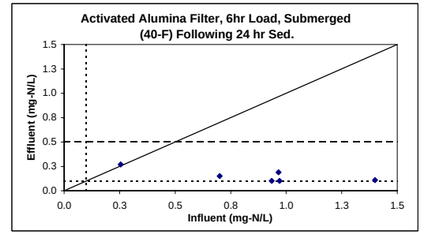


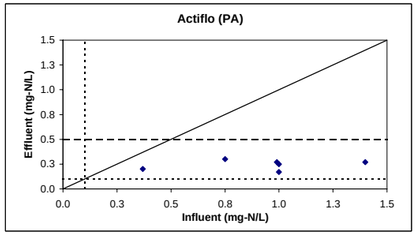


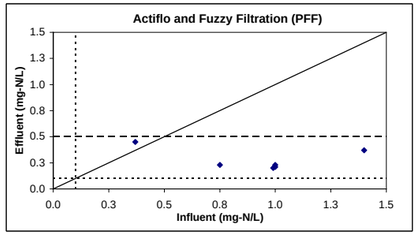


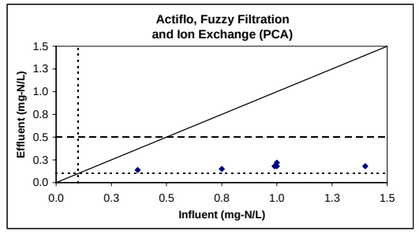






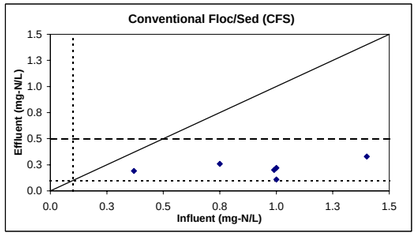


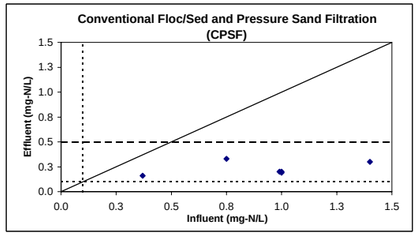


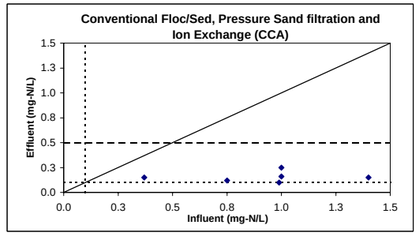


GENERAL LEGEND

- Sample Points (influent, effluent)
- One of several data points here is qualified
- Qualified Data Point
- Rejected Data Point
- 1 to 1 Influent to effluent sample concentration line - If the sample point is below this line, the concentration decreased through the treatment process. If the sample point falls above this line, the concentration increased through the treatment process.
- Maximum Lake Tahoe Basin surface water discharge for Total Nitrogen = 0.5 mg-N/L.
- Analytical reporting limit line - Not applicable for a calculated parameter, however all nitrogen species have a reporting limit = 0.1 mg-N/L







LEGEND FOR CHITOSAN SEDIMENTATION (30-S)

- Dose = 1 mg/L
- Eff Reg
- Report Limit Y
- Report Limit X
- Dose = 0.5 mg/L
- Dose = Passive

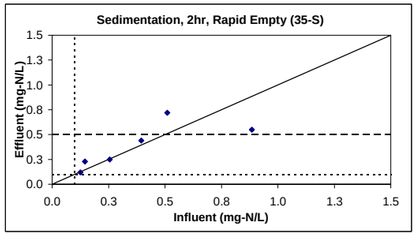
NOTES

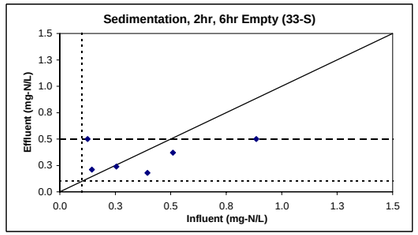
* Total Nitrogen = TKN-T + NO3 + NO2

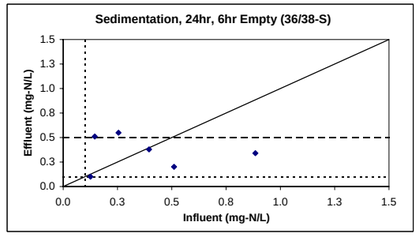
* Many of the TKN values used to calculate Total Nitrogen were qualified.

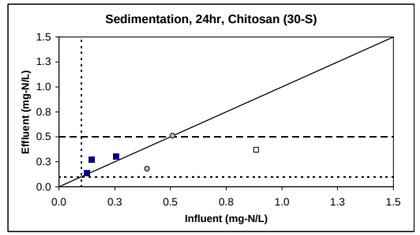
Figure 5-9. Nitrogen - Total

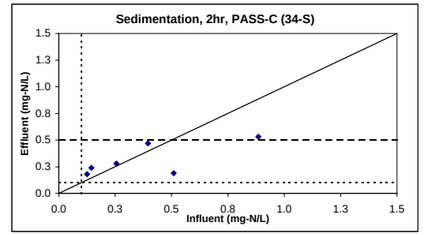
Nitrogen - Dissolved

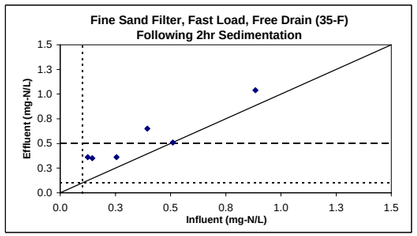


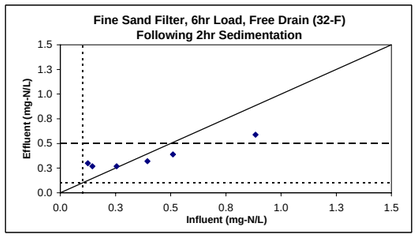


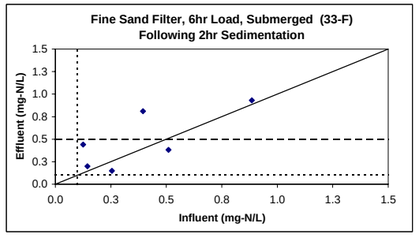


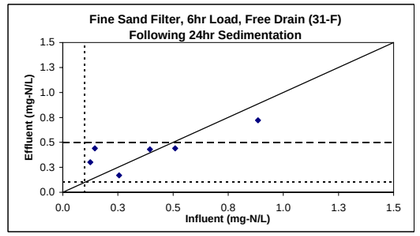


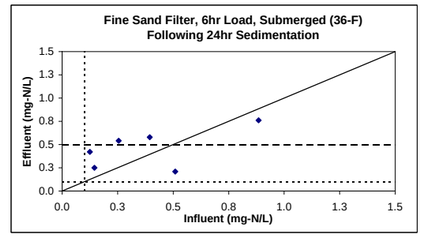


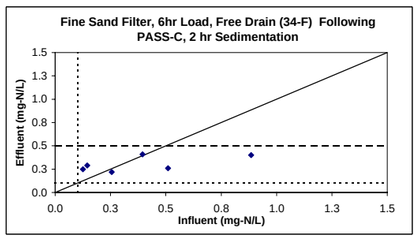


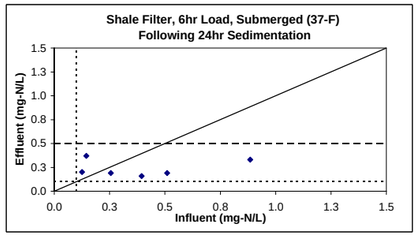


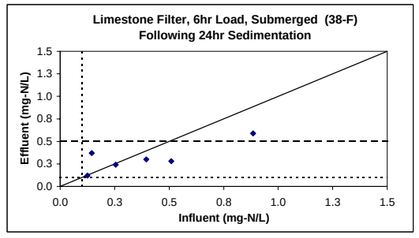


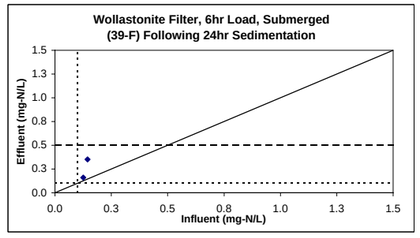


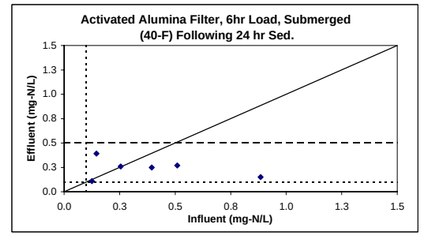


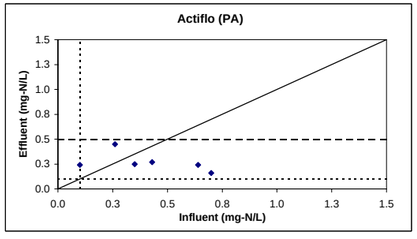


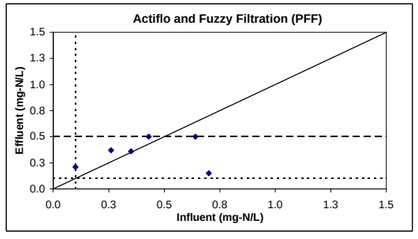


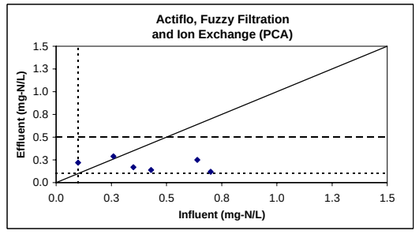






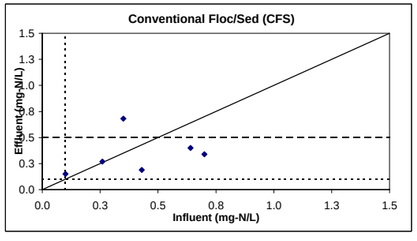


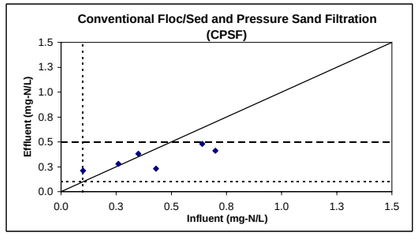


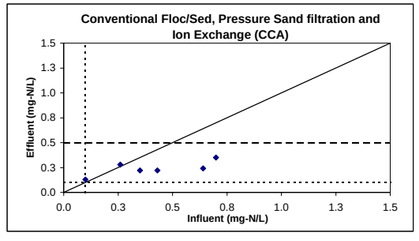


GENERAL LEGEND

- Sample Points (influent, effluent)
- One of several data points here is qualified
- Qualified Data Point
- Rejected Data Point
- 1 to 1 Influent to effluent sample concentration line - If the sample point is below this line, the concentration decreased through the treatment process. If the sample point falls above this line, the concentration increased through the treatment process.
- Maximum Lake Tahoe Basin surface water discharge for Total Nitrogen = 0.5 mg-N/L.
- Analytical reporting limit line - not applicable for a calculated parameter, however all nitrogen species have a reporting limit = 0.1 mg-N/L







LEGEND FOR CHITOSAN SEDIMENTATION (30-S)

- Dose = 1 mg/L
- Eff Reg
- Report Limit Y
- Report Limit X
- Dose = 0.5 mg/L
- Dose = Passive

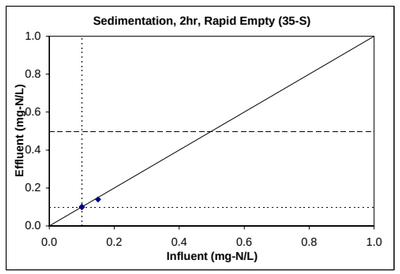
NOTES

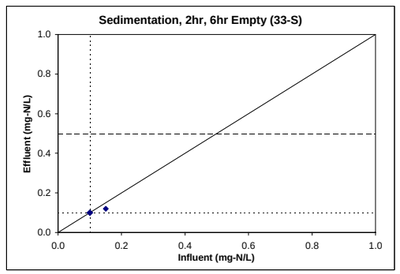
* Calculated parameter, qualified values not shown

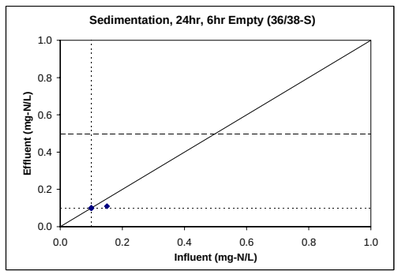
* Calculated as the sum of TKN-D + Nitrate + Nitrite

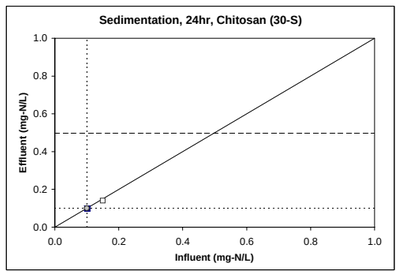
Figure 5-10. Nitrogen - Dissolved

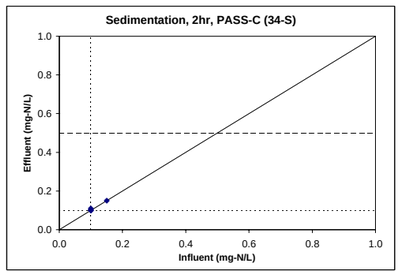
Nitrogen - Ammonia

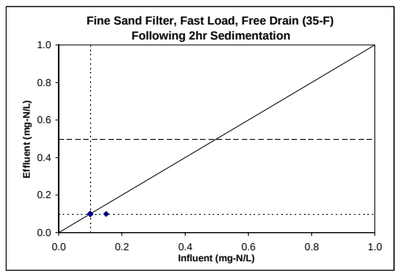


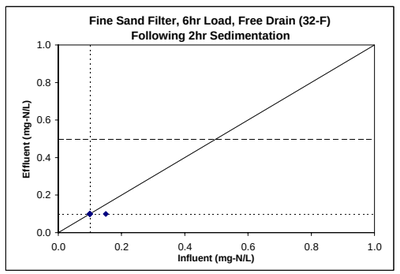


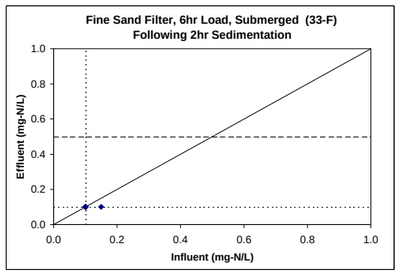


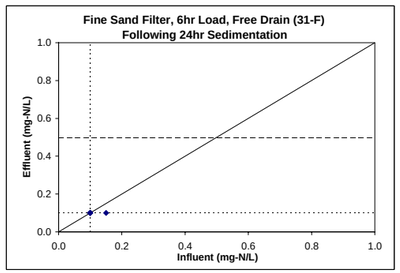


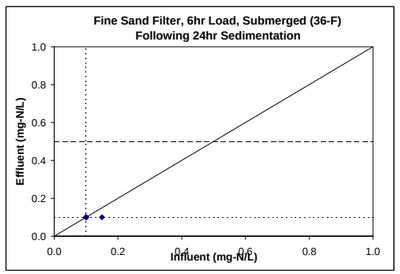


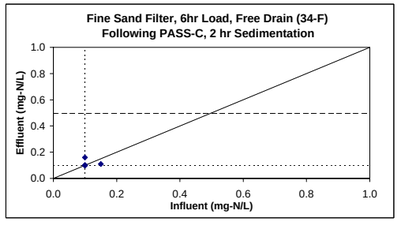


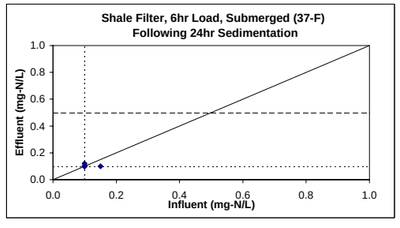


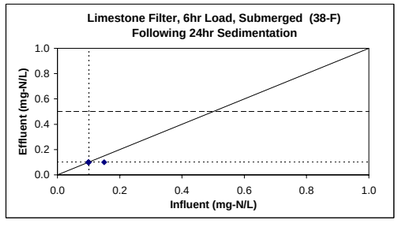


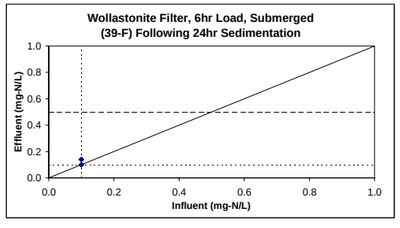


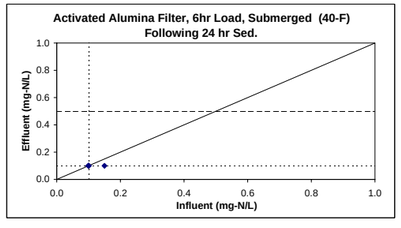


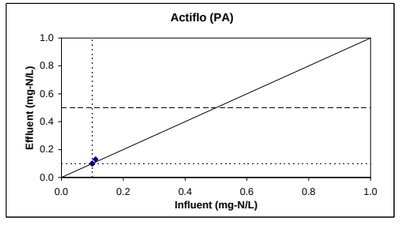


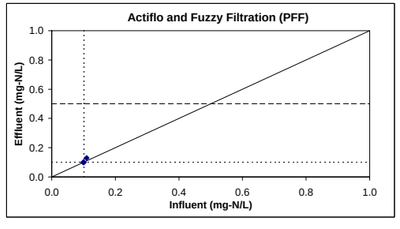


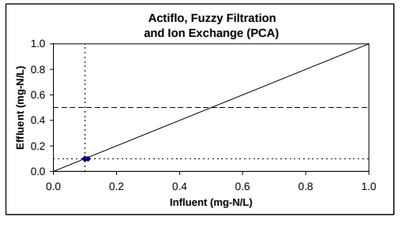






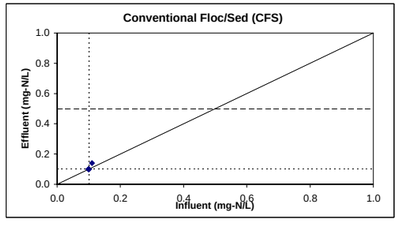


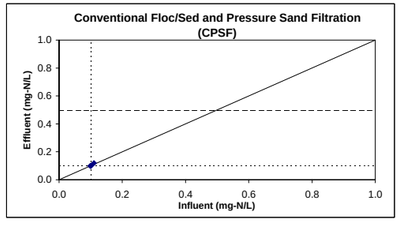


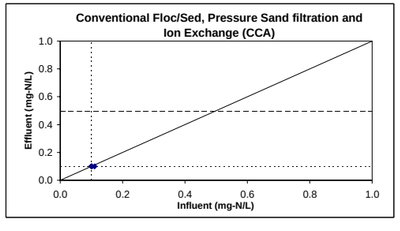


GENERAL LEGEND

- Sample Points (influent, effluent)
- One of several data points here is qualified
- Qualified Data Point
- Rejected Data Point
- 1 to 1 Influent to effluent sample concentration line - If the sample point is below this line, the concentration decreased through the treatment process. If the sample point falls above this line, the concentration increased through the treatment process.
- Maximum Lake Tahoe Basin surface water discharge for Total Nitrogen = 0.5 mg-N/L.
- Analytical reporting limit line - If sample points fall on these lines, the sample result was equal to the laboratory reporting limit (0.1 mg-N/L)







LEGEND FOR CHITOSAN SEDIMENTATION (30-S)

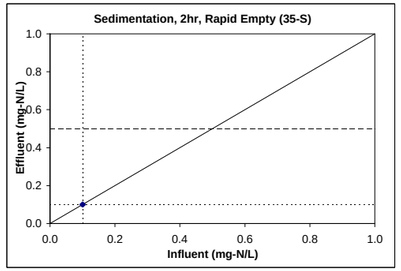
- Dose = 1 mg/L
- Eff Reg
- Report Limit Y
- Report Limit X
- Dose = 0.5 mg/L
- Dose = Passive

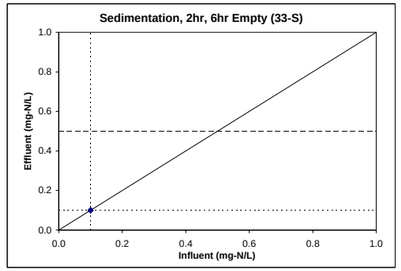
NOTES

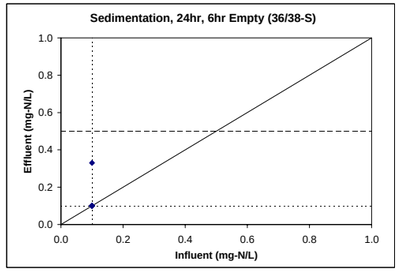
* All treatment plots have 6 data points, with the exception of the Wollastonite filter (39-F) which has 2. There are multiple points located at (<0.1, <0.1).

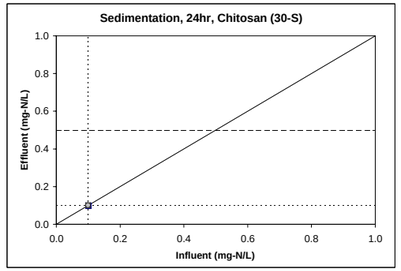
Figure 5-11. Nitrogen - Ammonia

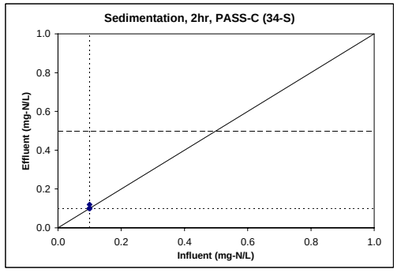
Nitrogen - Nitrate

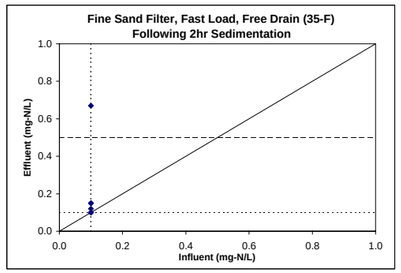


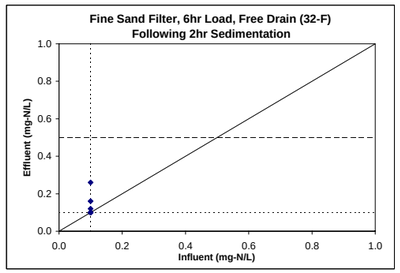


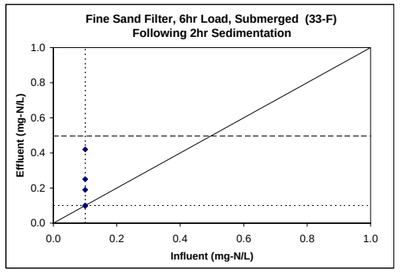


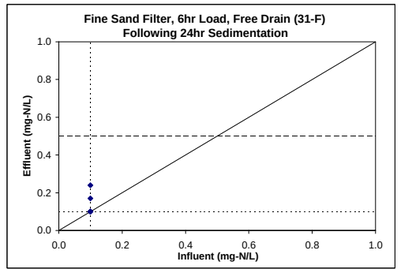


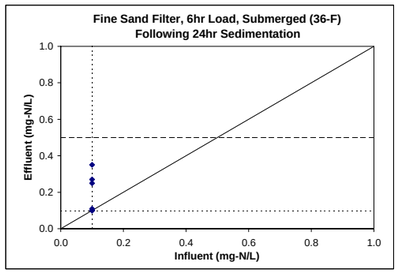


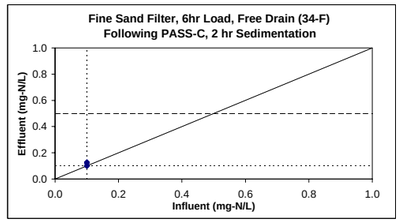


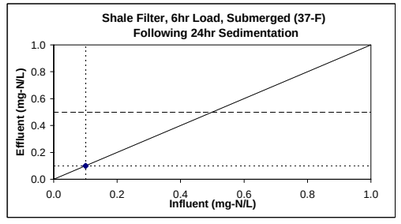


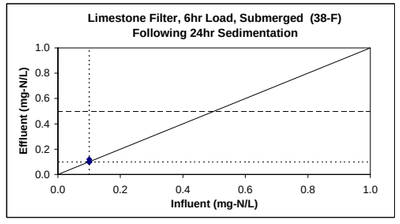


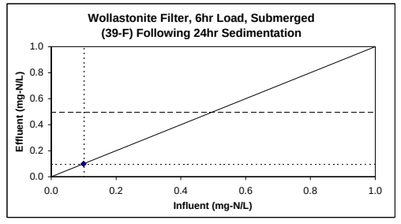


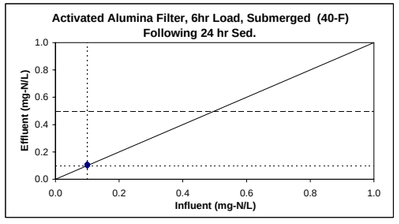


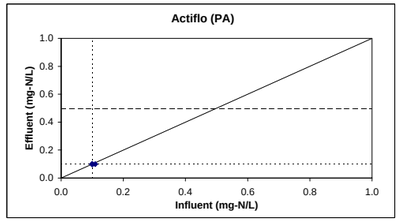


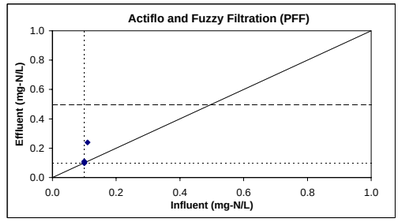


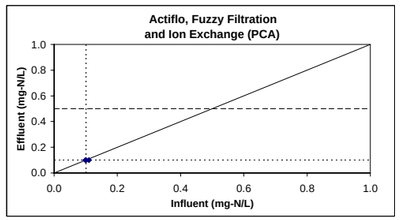






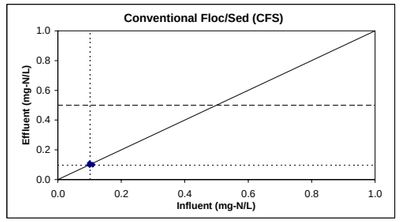


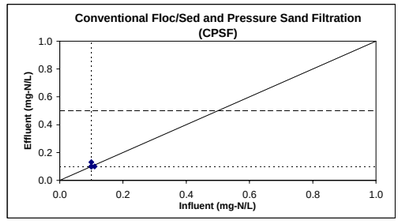


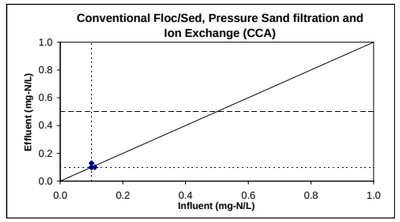


GENERAL LEGEND

- Sample Points (influent, effluent)
- One of several data points here is qualified
- Qualified Data Point
- Rejected Data Point
- 1 to 1 Influent to effluent sample concentration line - If the sample point is below this line, the concentration decreased through the treatment process. If the sample point falls above this line, the concentration increased through the treatment process.
- Maximum Lake Tahoe Basin surface water discharge for Total Nitrogen = 0.5 mg-N/L.
- Analytical reporting limit line - If sample points fall on these lines, the sample result was equal to the laboratory reporting limit (0.1 mg-N/L)







LEGEND FOR CHITOSAN SEDIMENTATION (30-S)

- Dose = 1 mg/L
- Eff Reg
- Report Limit Y
- Report Limit X
- Dose = 0.5 mg/L
- Dose = Passive

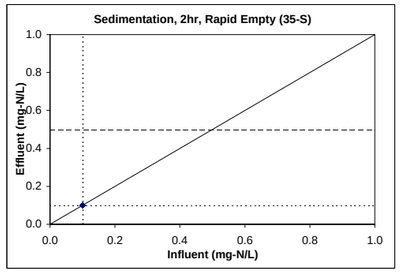
NOTES

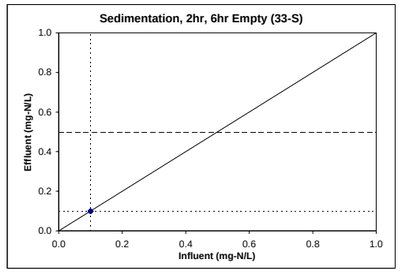
* Outlier Point Not Plotted - 38-S (12-38-S had a nitrate value of 3.5 mg/L which is not considered to be valid)

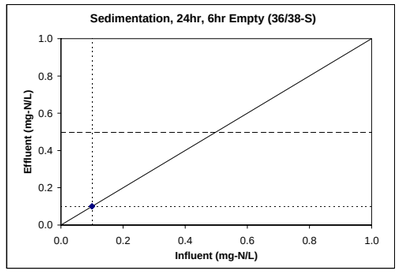
* All treatment plots have 6 data points, with the exception of the Wollastonite filter (39-F) which has 2. There are multiple points located at (<0.1, <0.1).

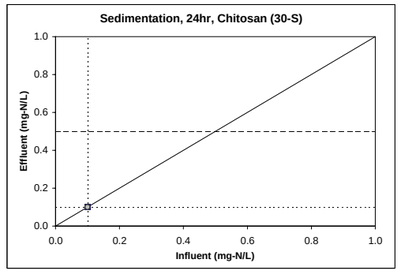
Figure 5-12. Nitrogen - Nitrate

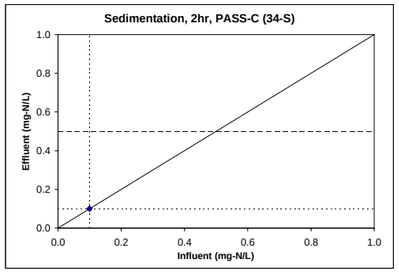
Nitrogen - Nitrite

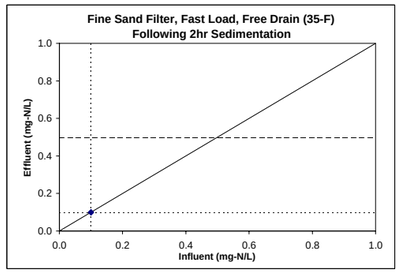


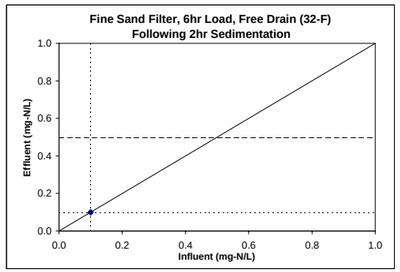


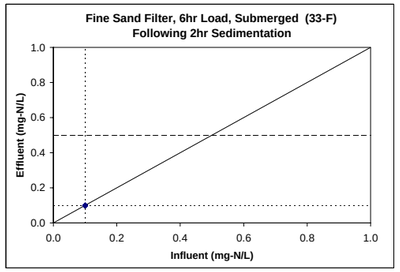


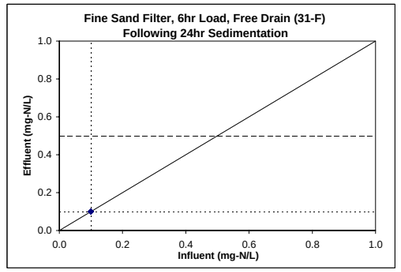


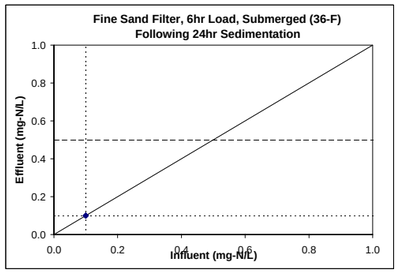


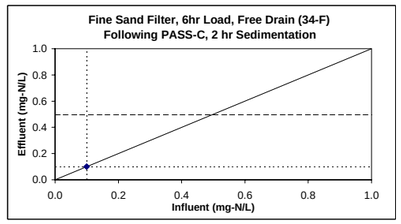


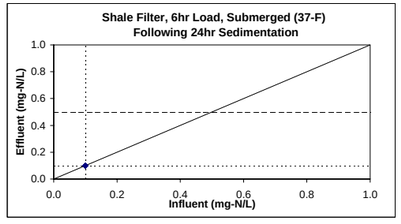


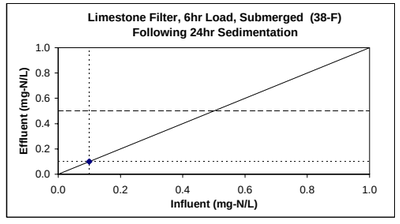


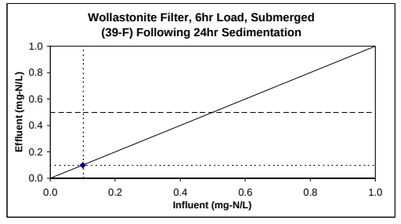


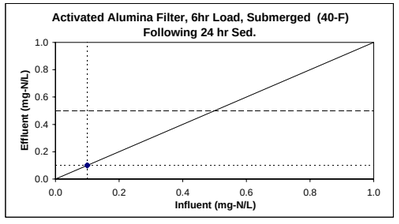


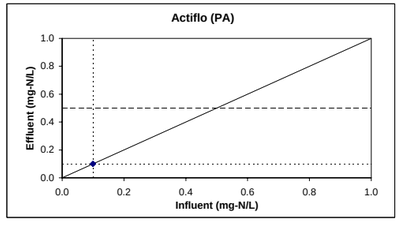


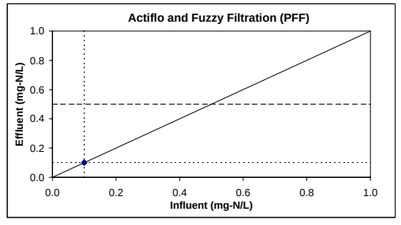


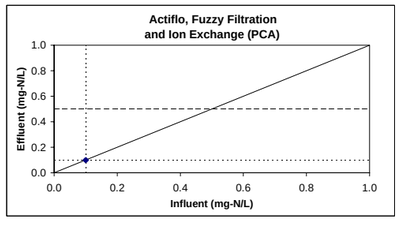






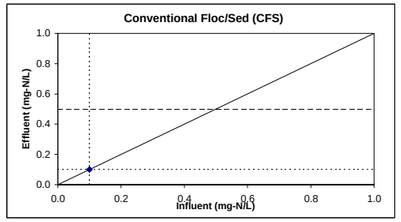


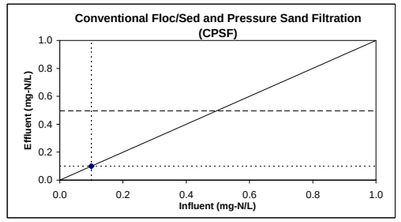


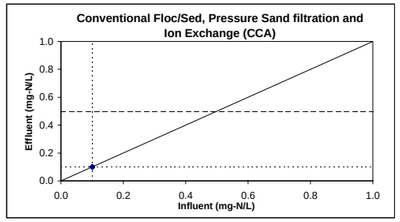


GENERAL LEGEND

- Sample Points (influent, effluent)
- One of several data points here is qualified
- Qualified Data Point
- Rejected Data Point
- 1 to 1 Influent to effluent sample concentration line - If the sample point is below this line, the concentration decreased through the treatment process. If the sample point falls above this line, the concentration increased through the treatment process.
- Maximum Lake Tahoe Basin surface water discharge for Total Nitrogen = 0.5 mg-N/L.
- Analytical reporting limit line - If sample points fall on these lines, the sample result was equal to the laboratory reporting limit (0.1 mg/L)







LEGEND FOR CHITOSAN SEDIMENTATION (30-S)

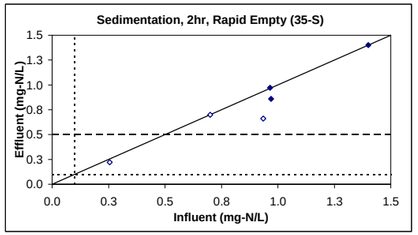
- Dose = 1 mg/L
- Eff Reg
- Report Limit Y
- Report Limit X
- Dose = 0.5 mg/L
- Dose = Passive

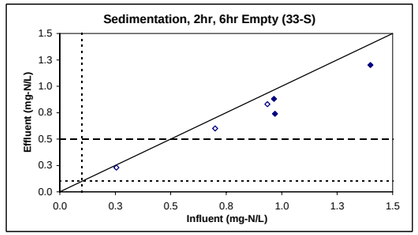
NOTES

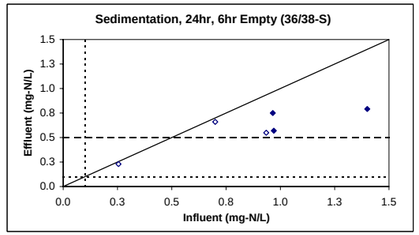
* No nitrite present on any of the samples collected.

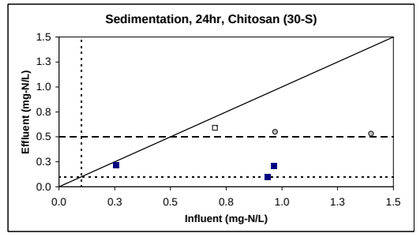
Figure 5-13. Nitrogen - Nitrite

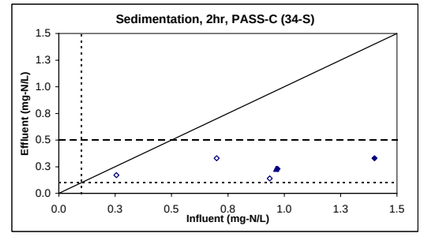
Nitrogen - Total Kjeldahl Nitrogen (TKN-T)

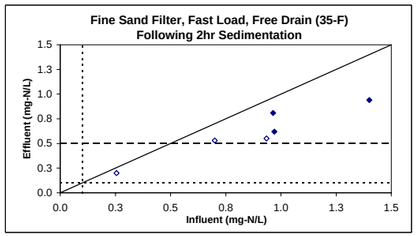


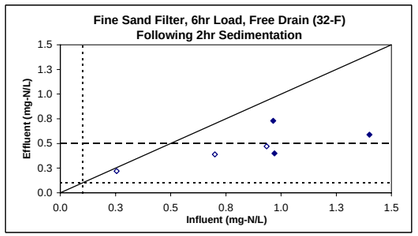


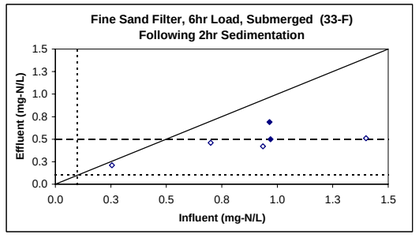


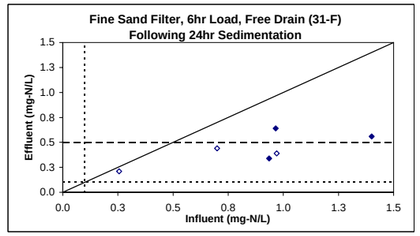


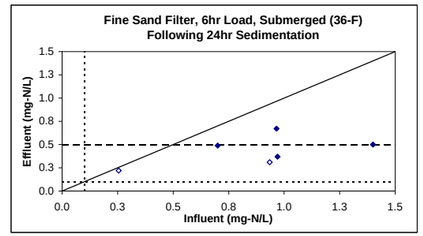


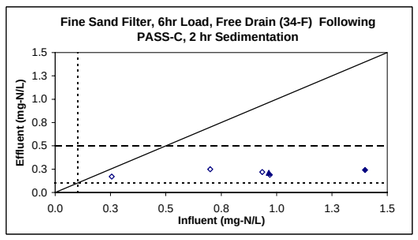


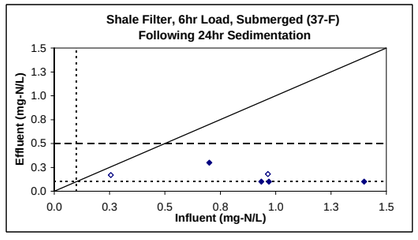


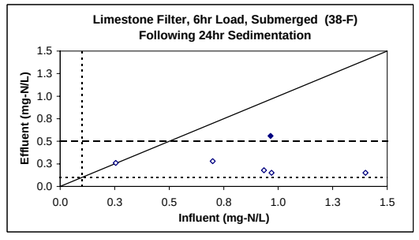


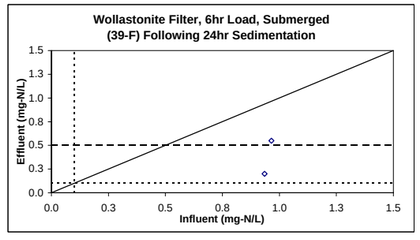


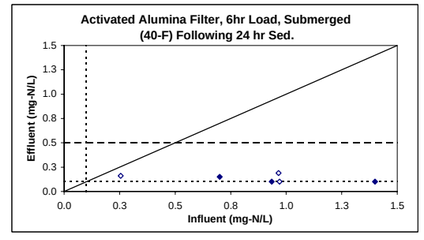


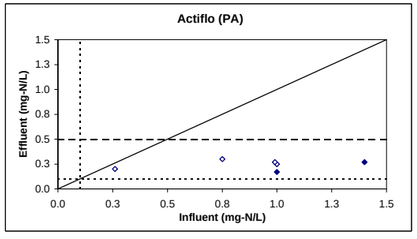


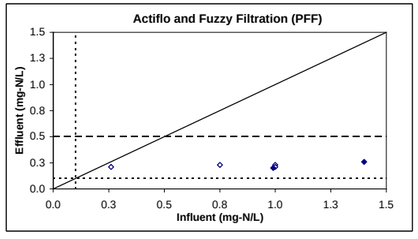


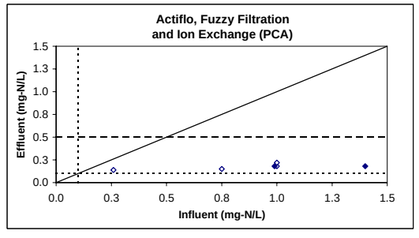






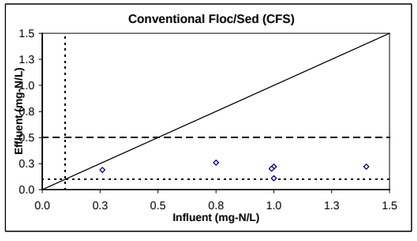


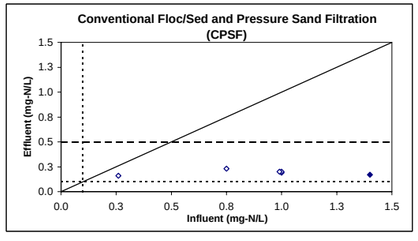


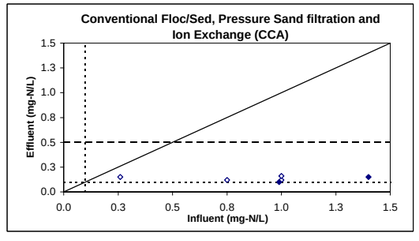


GENERAL LEGEND

- Sample Points (influent, effluent)
- One of several data points here is qualified
- Qualified Data Point
- Rejected Data Point
- 1 to 1 Influent to effluent sample concentration line - If the sample point is below this line, the concentration decreased through the treatment process. If the sample point falls above this line, the concentration increased through the treatment process.
- Maximum Lake Tahoe Basin surface water discharge for Total Nitrogen = 0.5 mg-N/L.
- Analytical reporting limit line - If sample points fall on these lines, the sample result was equal to the laboratory reporting limit (0.1 mg-N/L)







LEGEND FOR CHITOSAN SEDIMENTATION (30-S)

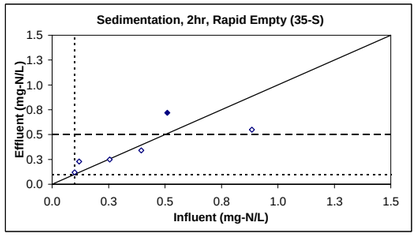
- Dose = 1 mg/L
- Eff Reg
- Report Limit Y
- Report Limit X
- Dose = 0.5 mg/L
- Dose = Passive

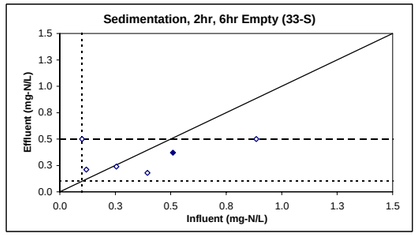
NOTES

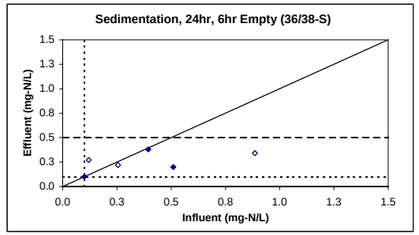
* Qualified values a result of laboratory background/blank contamination.

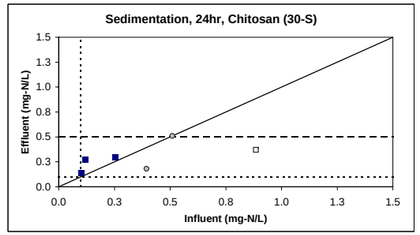
Figure 5-14. Nitrogen - Total Kjeldahl Nitrogen (TKN-T)

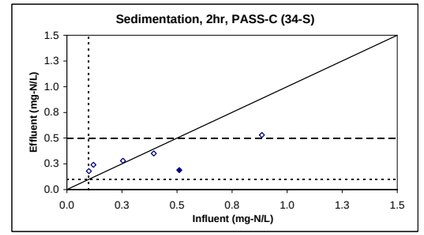
Nitrogen - Dissolved Kjeldahl Nitrogen (TKN-D)

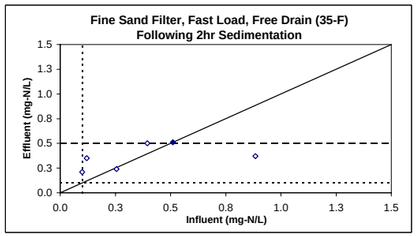


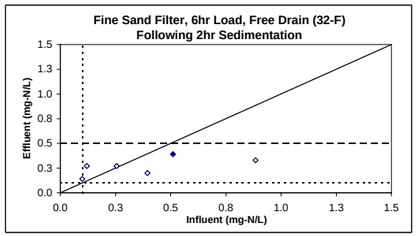


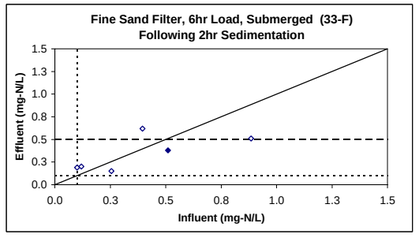


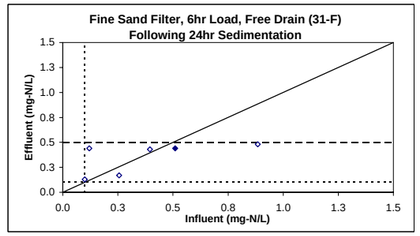


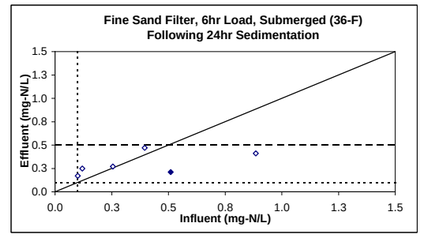


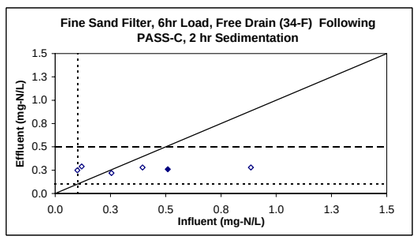


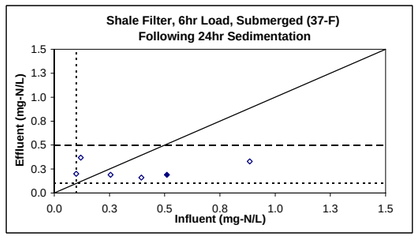


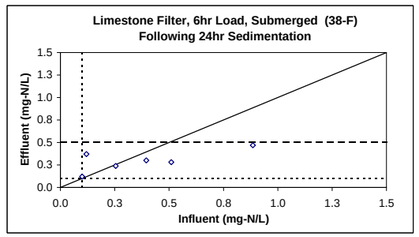


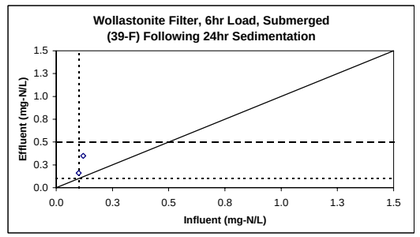


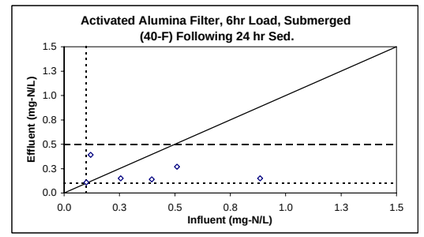


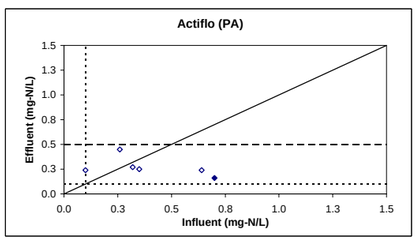


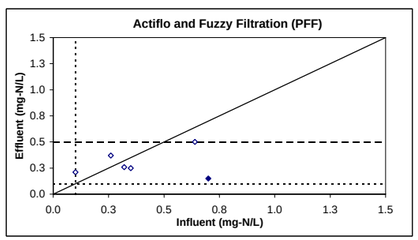


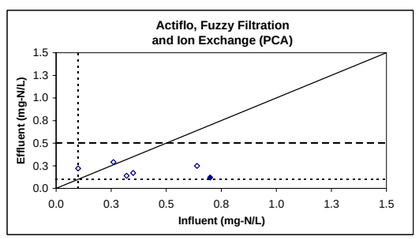












GENERAL LEGEND

- Sample Points (influent, effluent)
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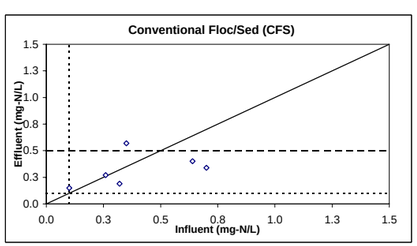
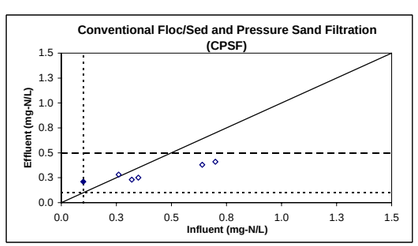
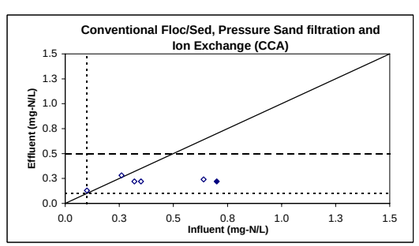
- Analytical reporting limit line - If sample points fall on these lines, the sample result was equal to the laboratory reporting limit (0.1 mg-N/L)







LEGEND FOR CHITOSAN SEDIMENTATION (30-S)

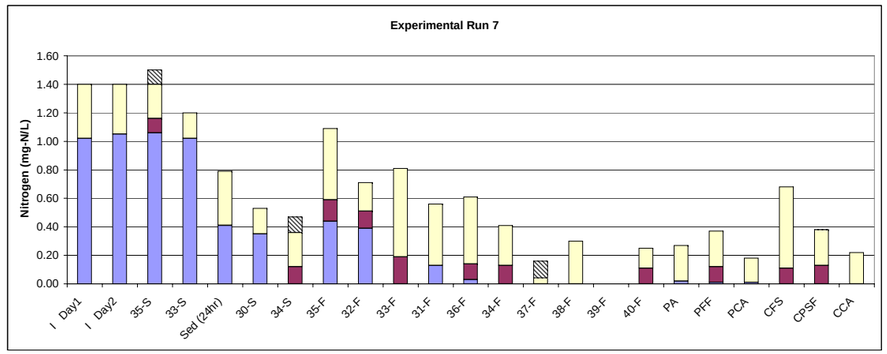
- Dose = 1 mg/L
- Eff Reg
- Report Limit Y
- Report Limit X
- Dose = 0.5 mg/L
- Dose = Passive

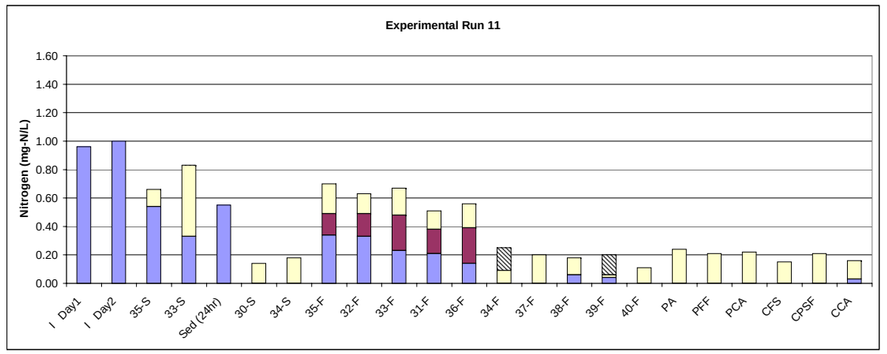
NOTES

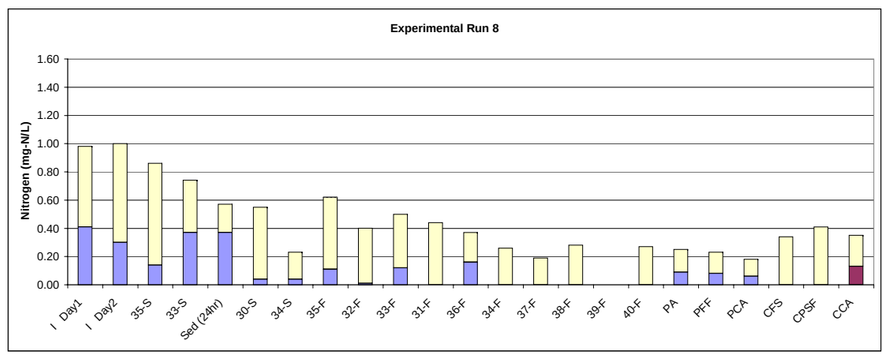
* Qualified values a result of laboratory background/blank contamination.

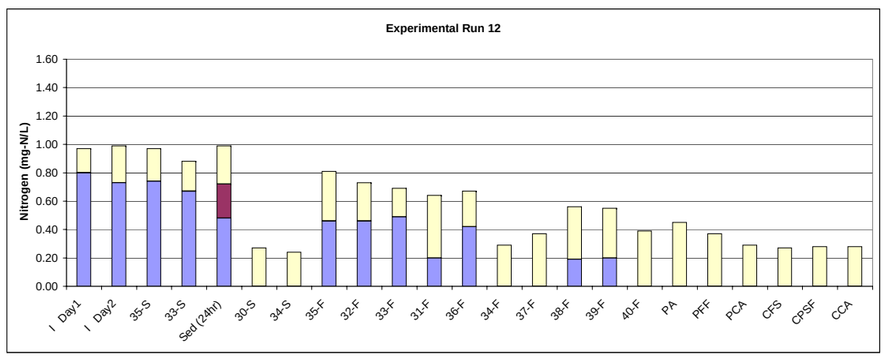
Figure 5-15. Nitrogen - Dissolved Kjeldahl Nitrogen (TKN-D)

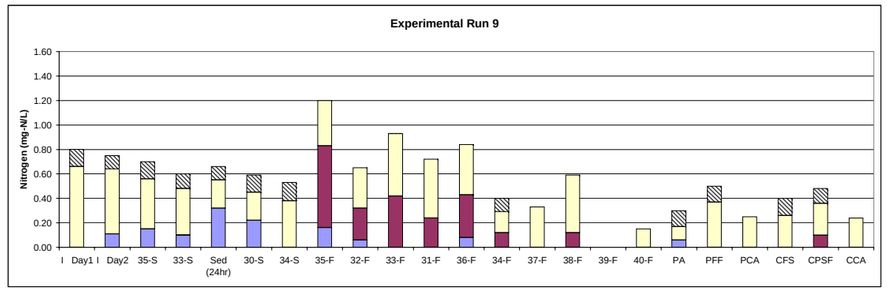
Forms of Nitrogen - Before and After Treatment

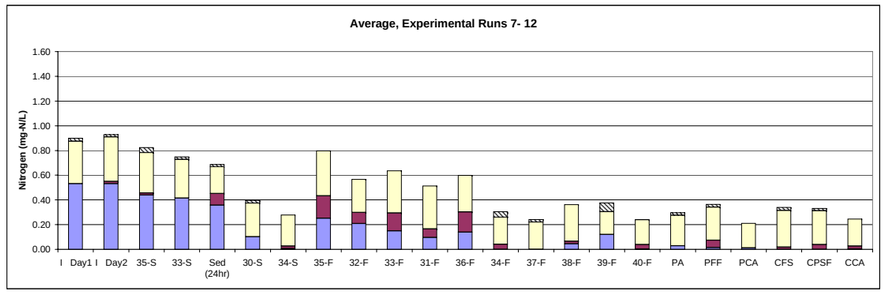


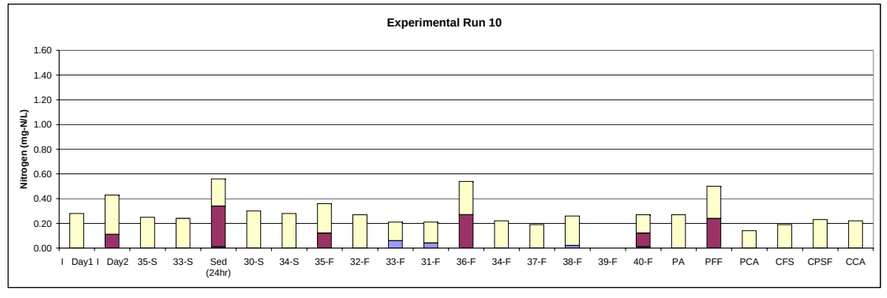












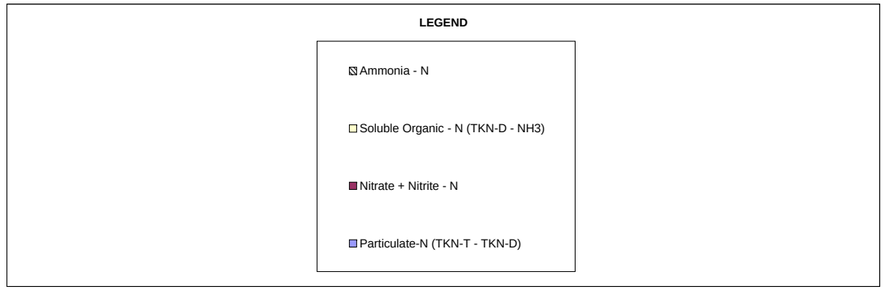
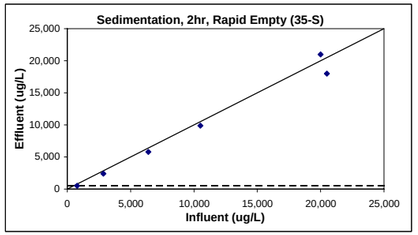
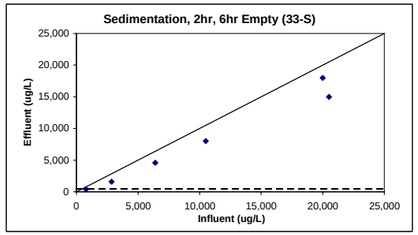
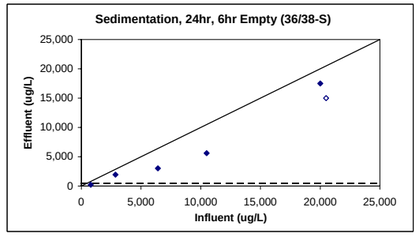


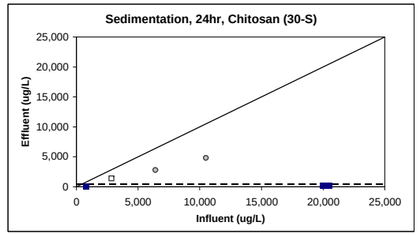
Figure 5-16. Forms of Nitrogen - Before and After Treatment

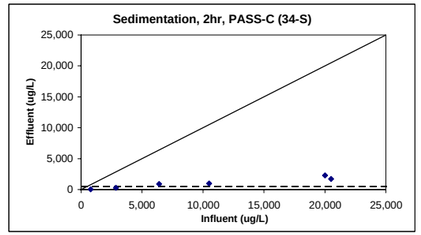
Iron - Total

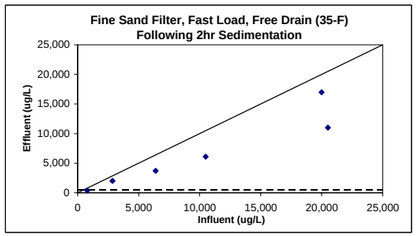


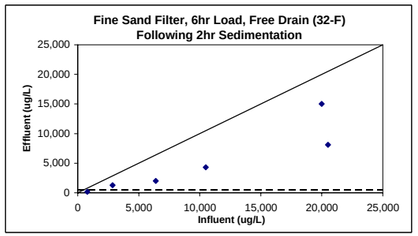


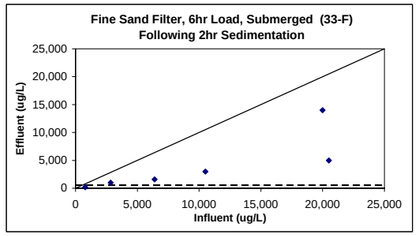


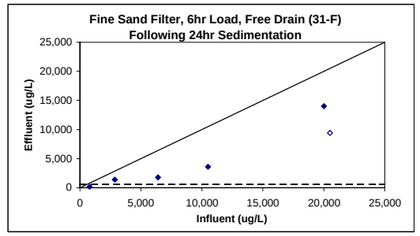


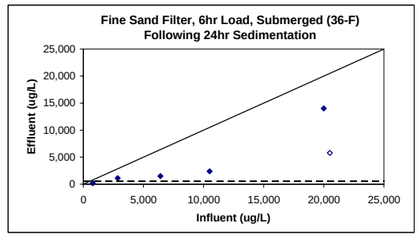


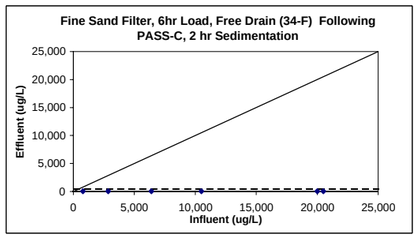


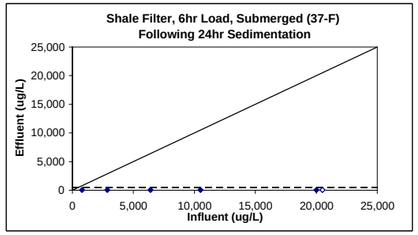


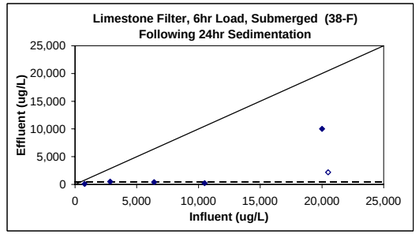


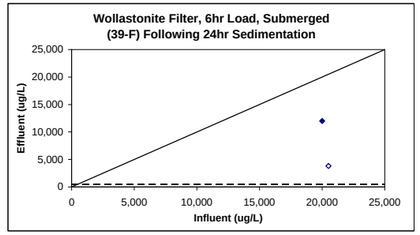


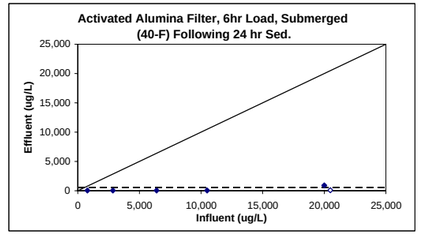


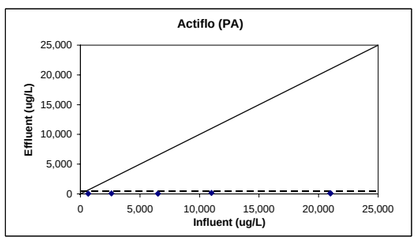


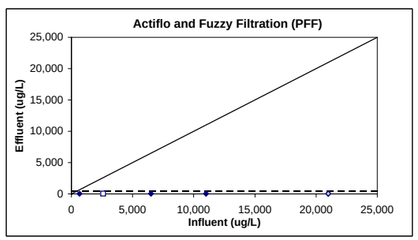


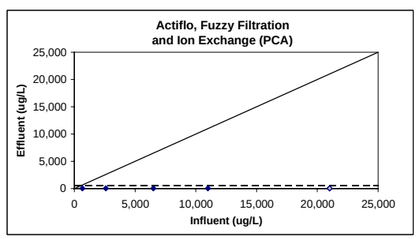


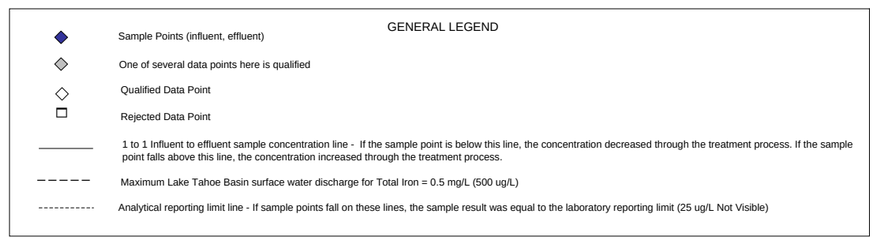


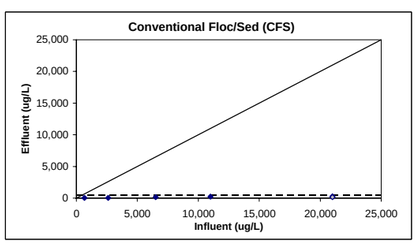


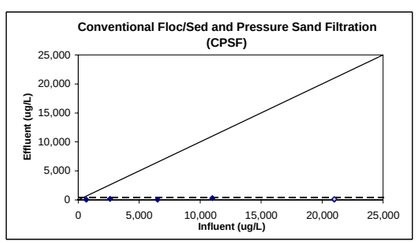


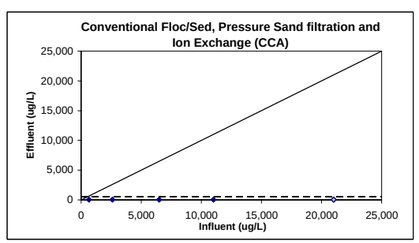


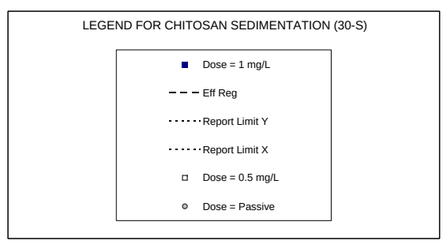












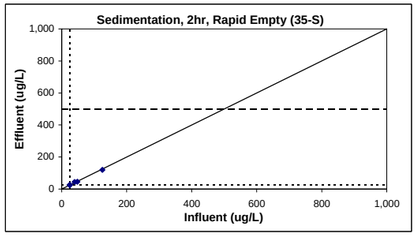
NOTES

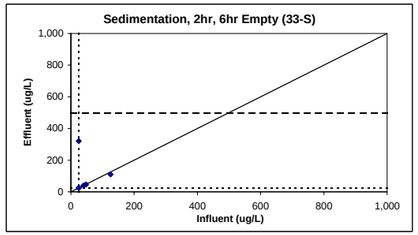
* All treatment plots have 6 data points, with the exception of the Wollastonite filter (39-F) which has 2.

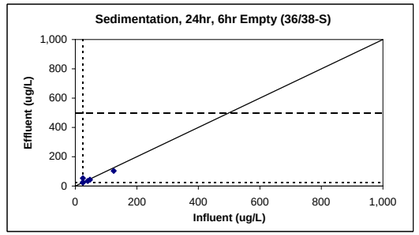
* Mechanized system plots have two data points nearly superimposed at (21,000, 100).

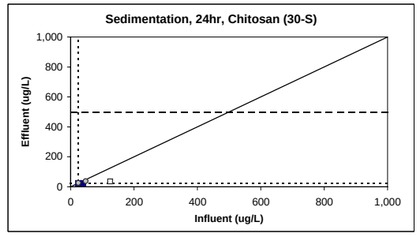
Figure 5-17. Iron - Total

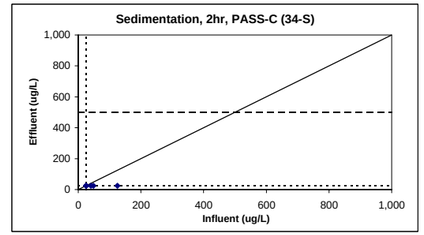
Iron - Dissolved

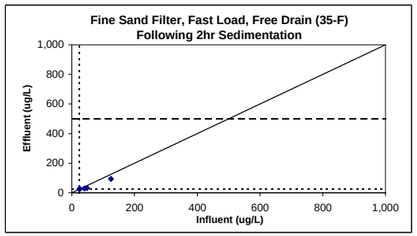


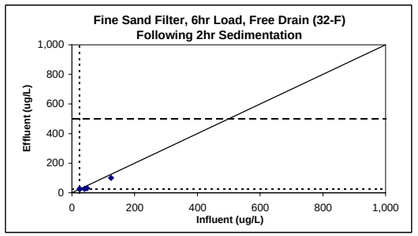


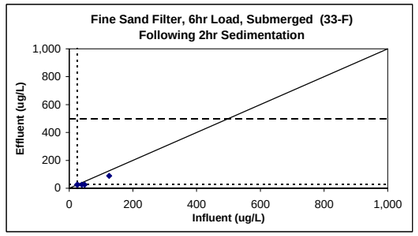


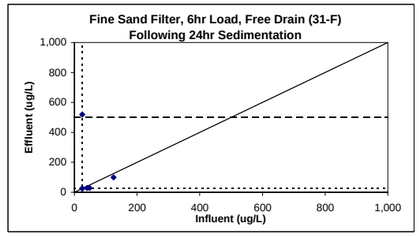


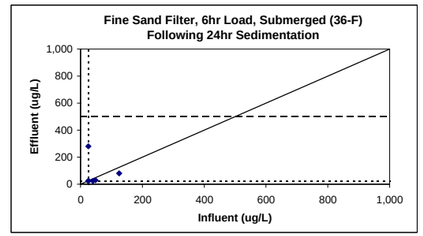


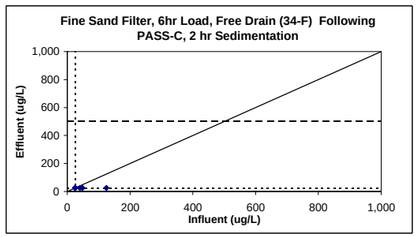


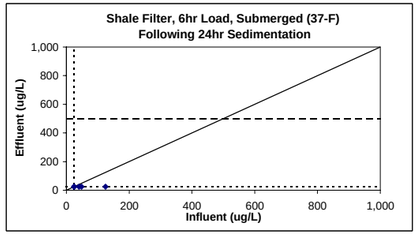


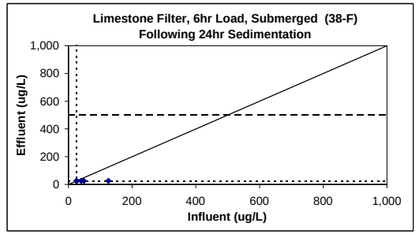


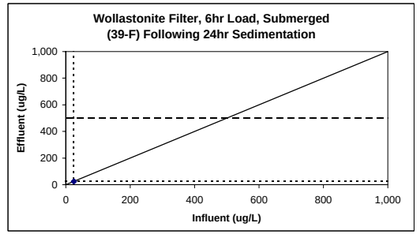


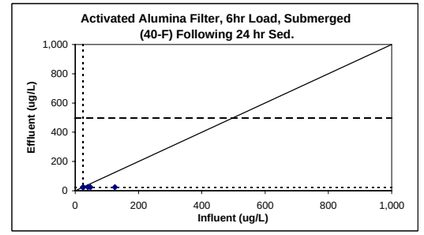


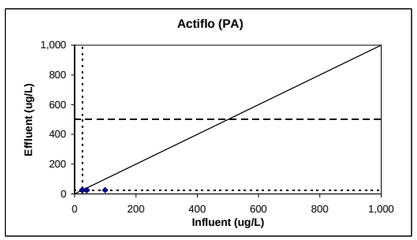


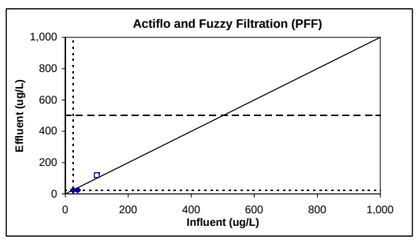


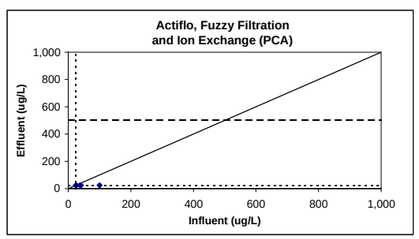


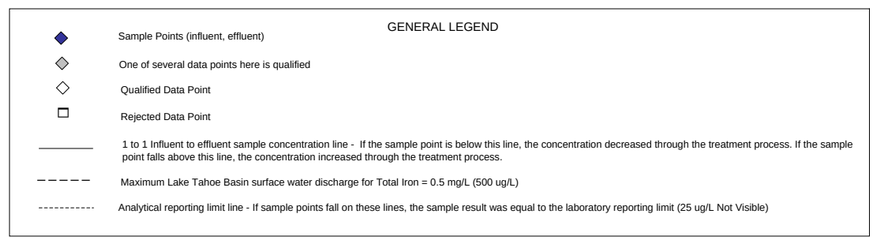


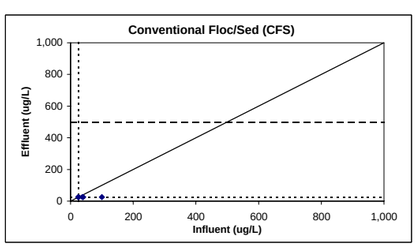


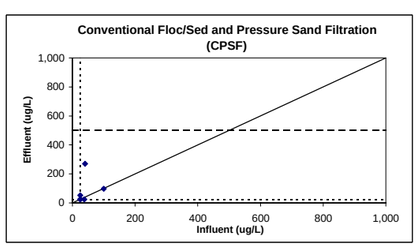


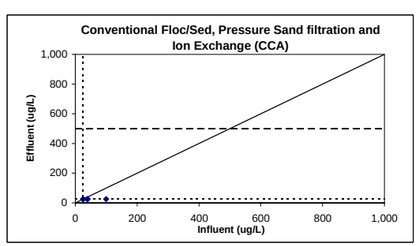


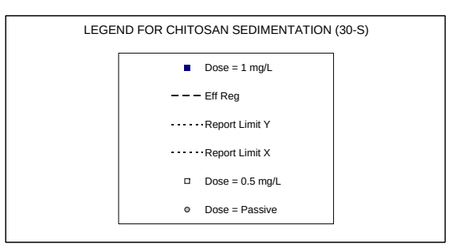










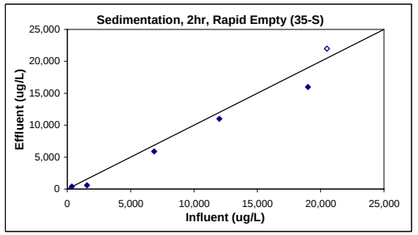


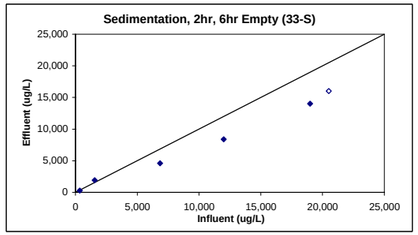
NOTES

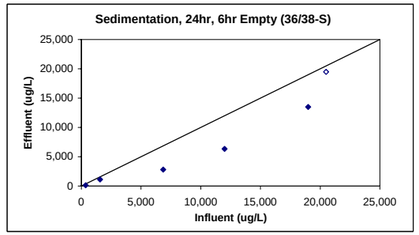
* All treatment plots have 6 data points, with the exception of the Wollastonit filter (39-F) which has 2. Multiple points clustered around (<25, <25)

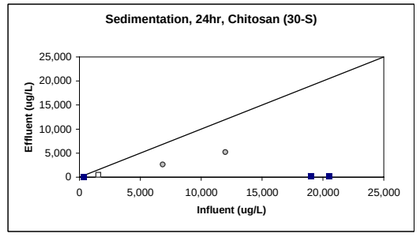
Figure 5-18. Iron - Dissolved

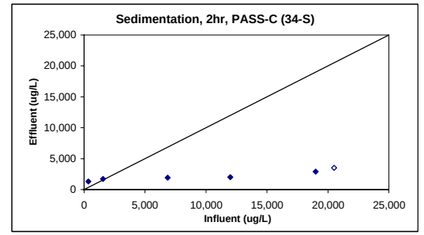
Aluminum - Total

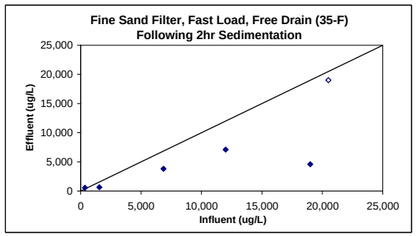


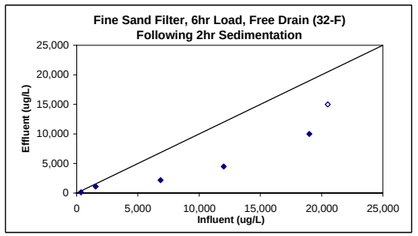


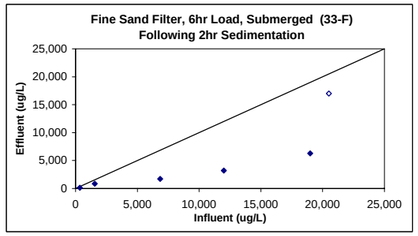


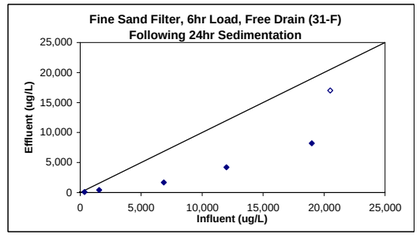


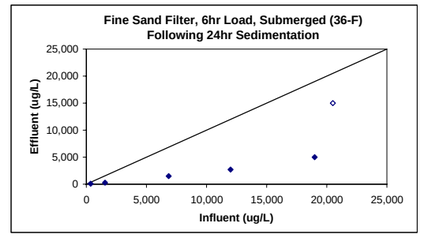


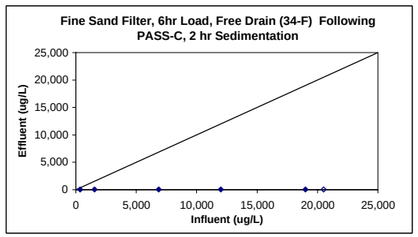


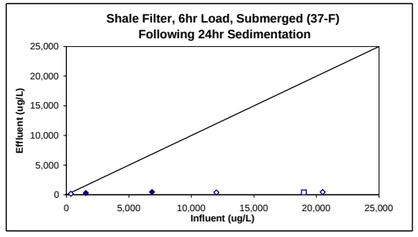


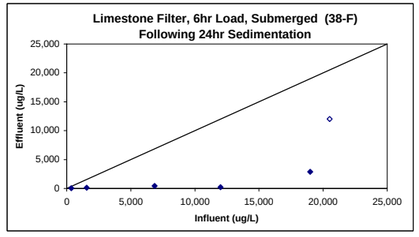


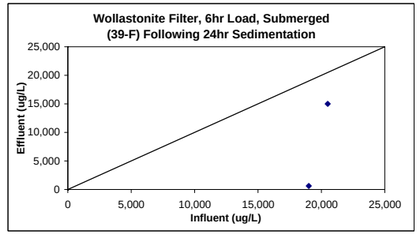


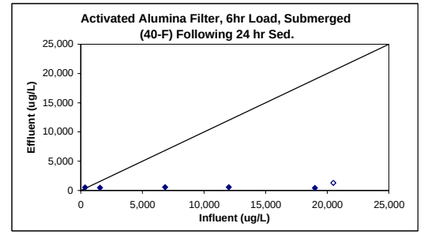


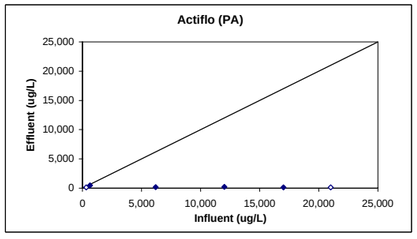


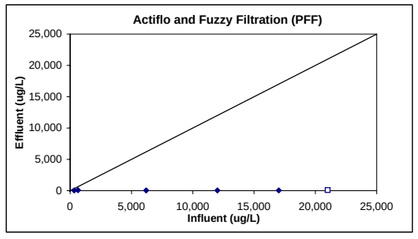


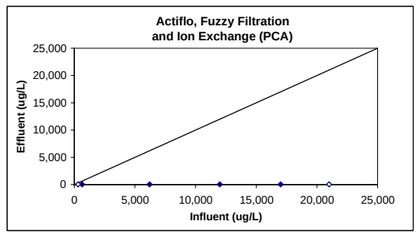


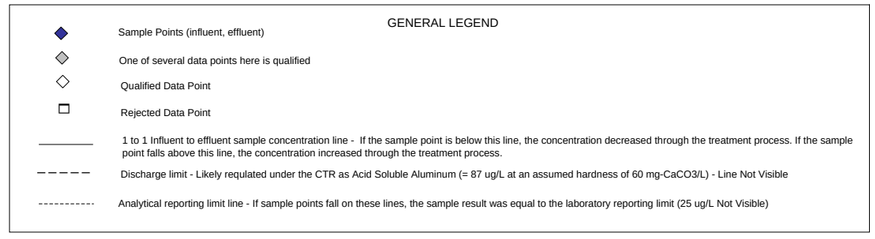


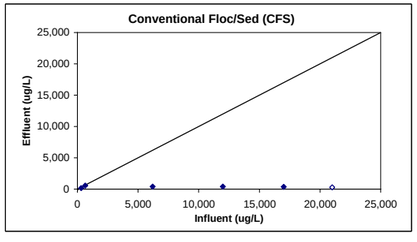


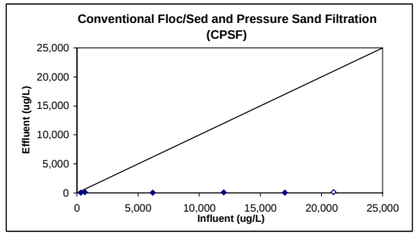


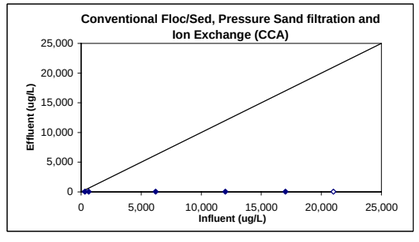


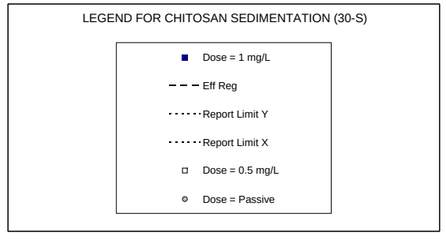












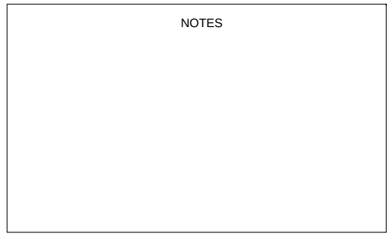
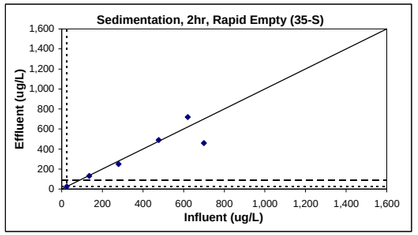
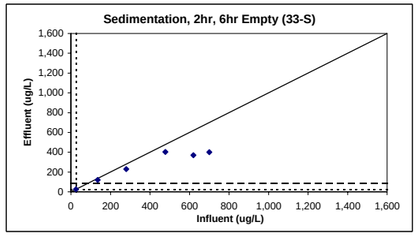
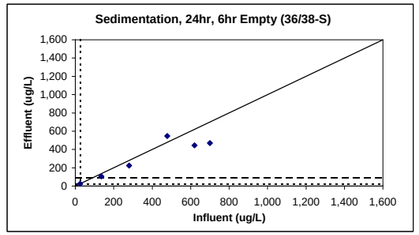


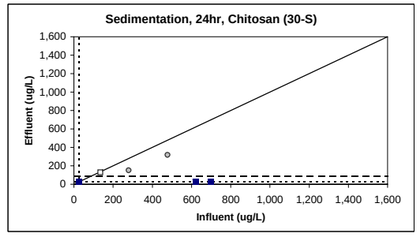
Figure 5-19. Aluminum - Total

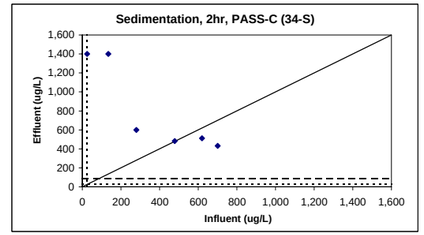
Aluminum - Acid Soluble

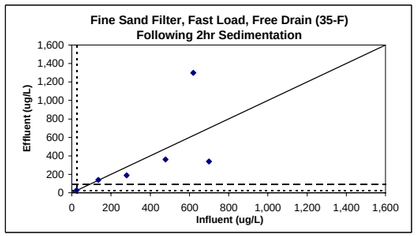


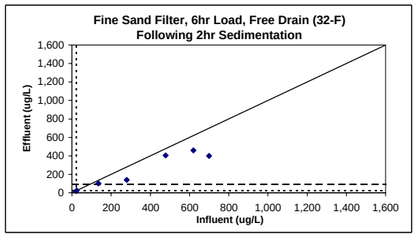


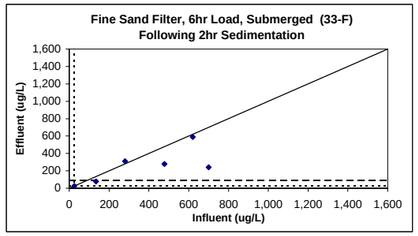


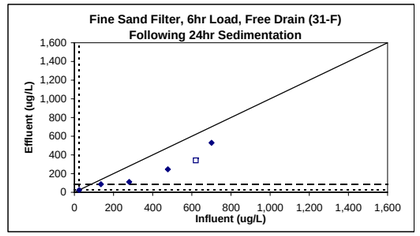


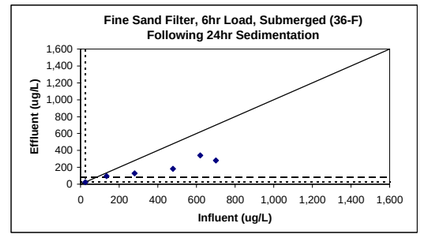


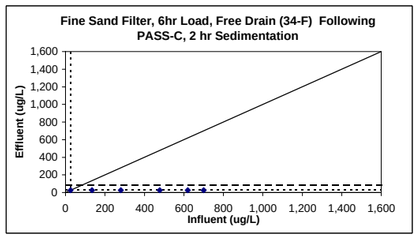


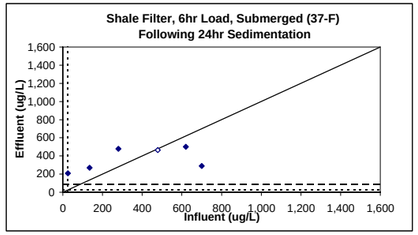


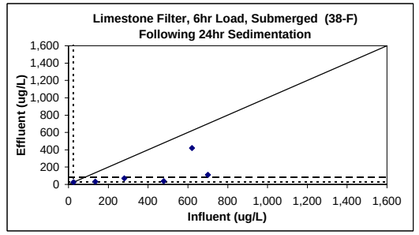


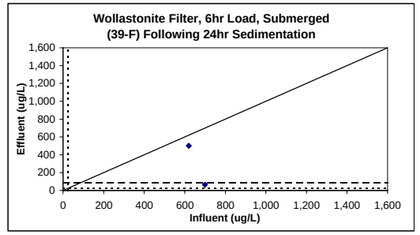


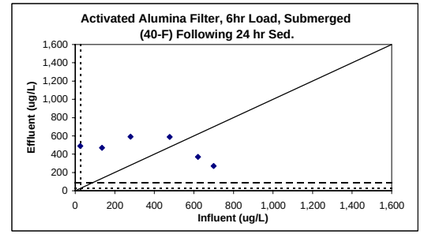


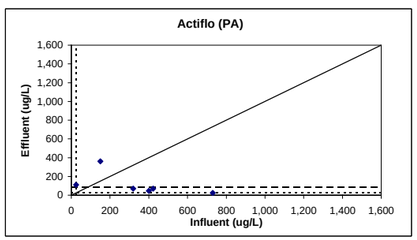


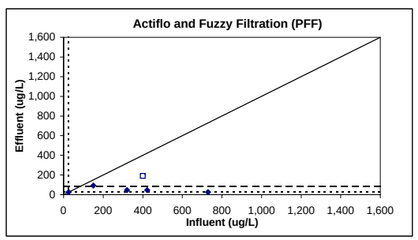


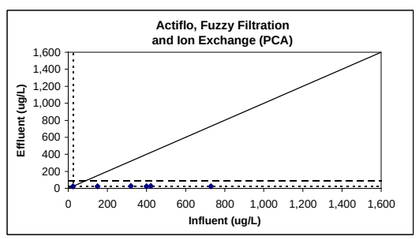


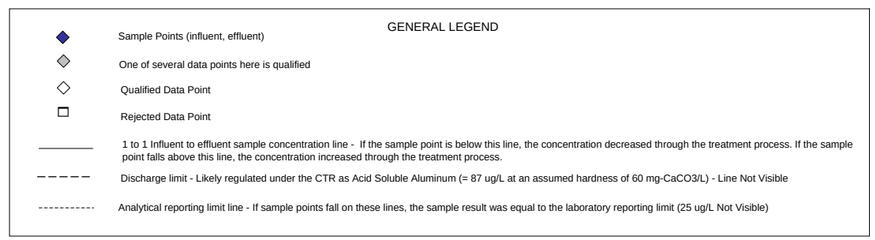


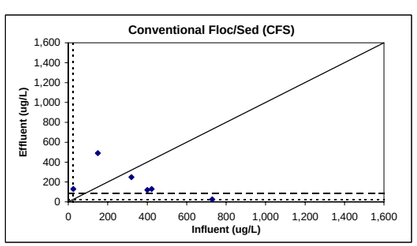


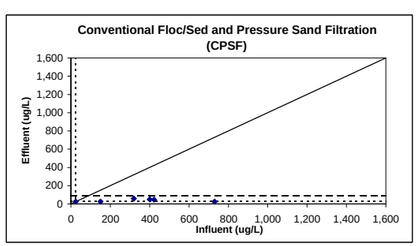


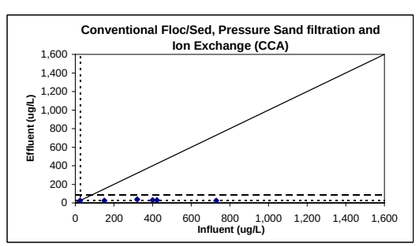


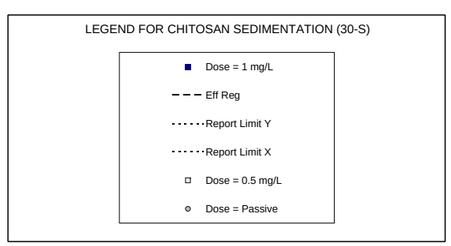












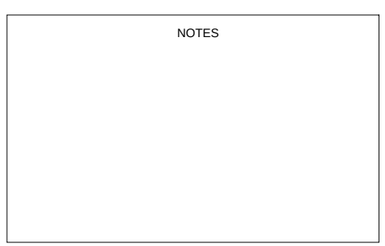
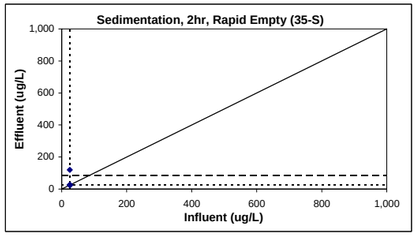
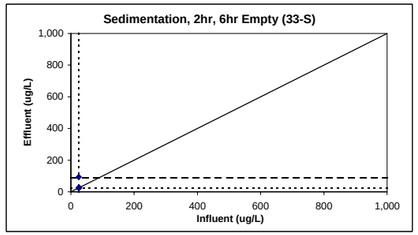
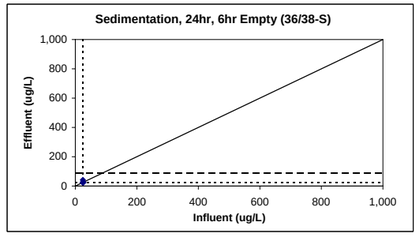


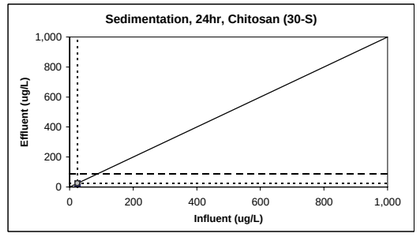
Figure 5-20. Aluminum - Acid Soluble

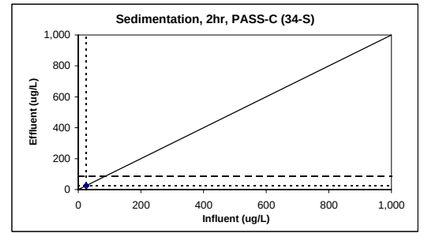
Aluminum - Dissolved

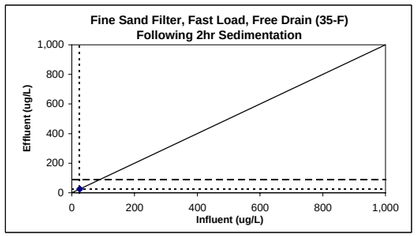


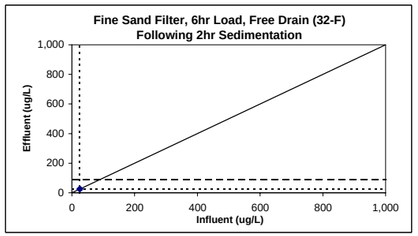


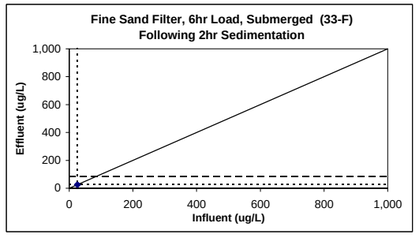


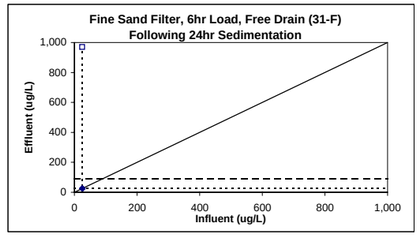


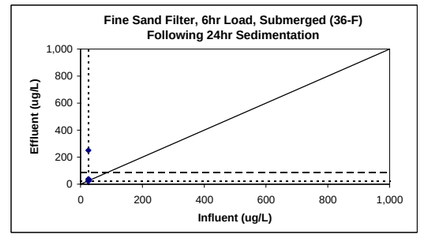


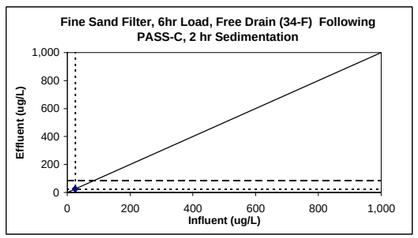


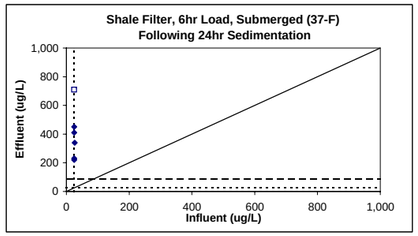


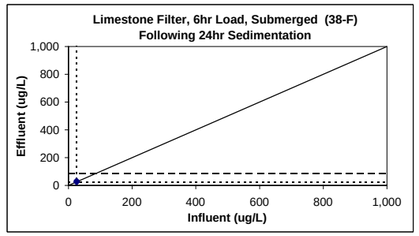


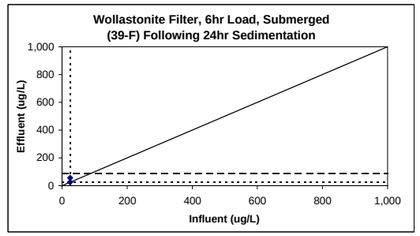


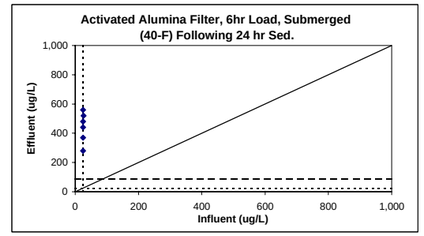


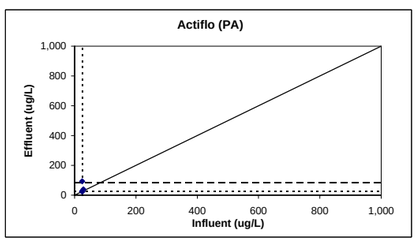


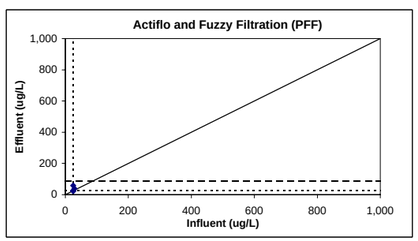


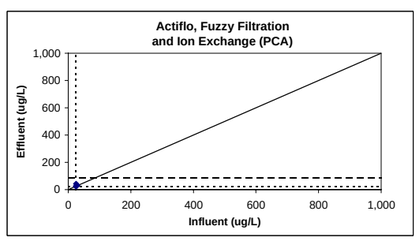


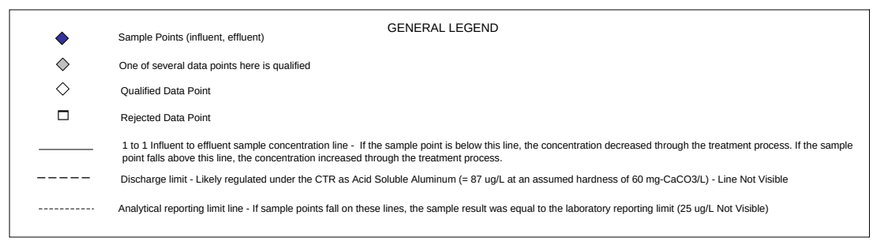


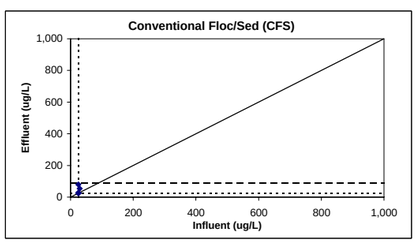


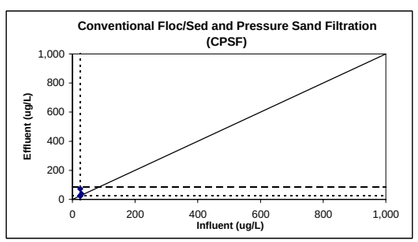


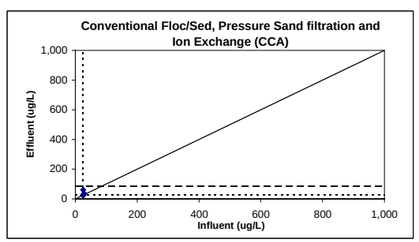


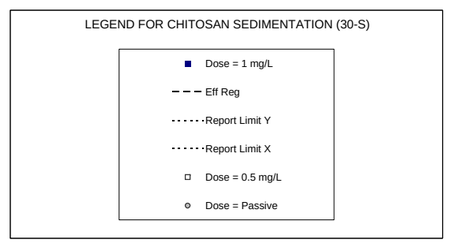










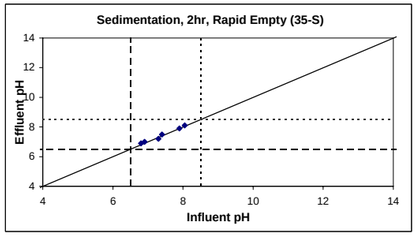


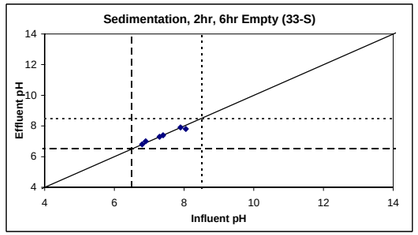
NOTES

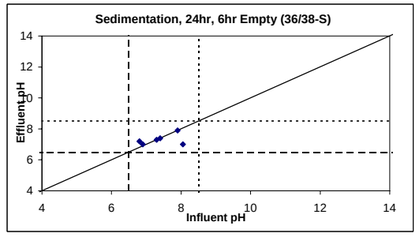
* All treatment plots have 6 data points, with the exception of the Wollastonite filter (39-F) which has 2. There are multiple points located at (<25, <25).

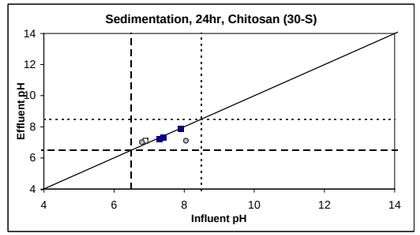
Figure 5-21. Aluminum - Dissolved

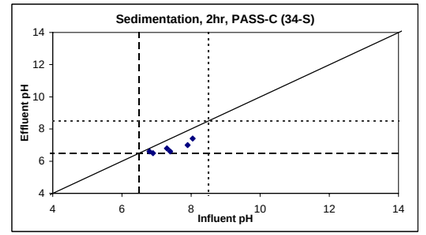
pH Value

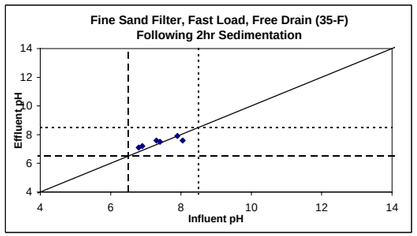


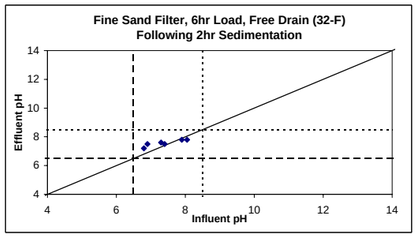


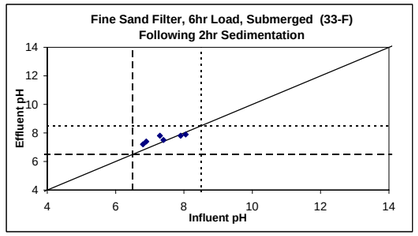


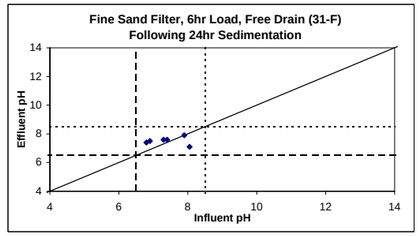


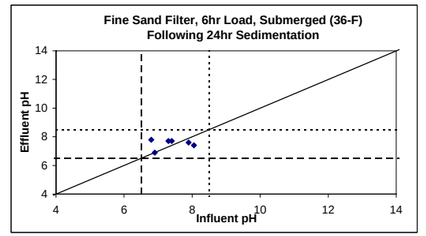


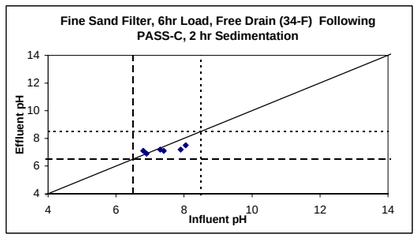


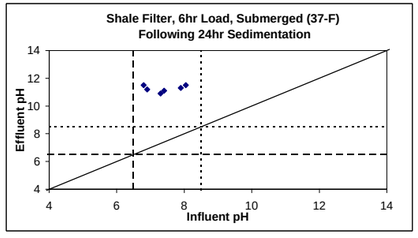


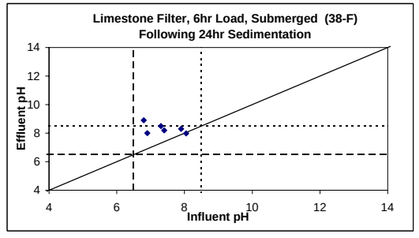


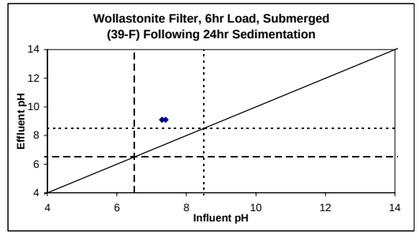


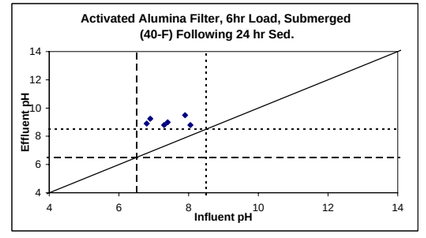


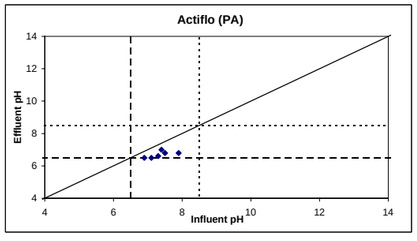


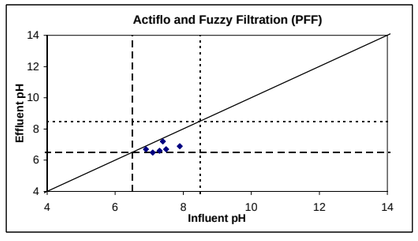


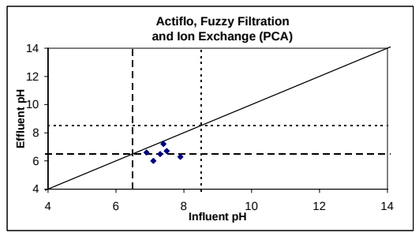


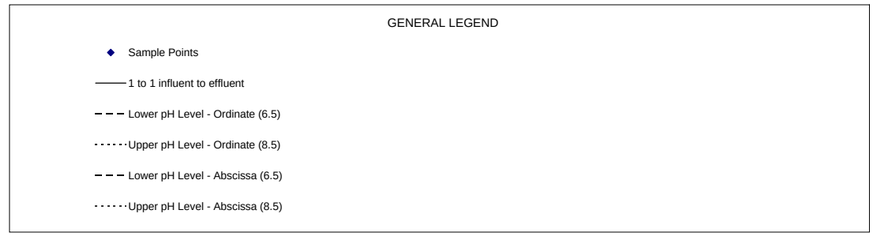


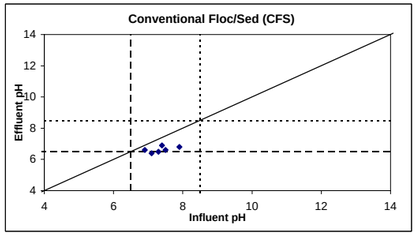


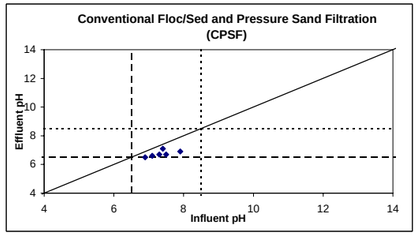


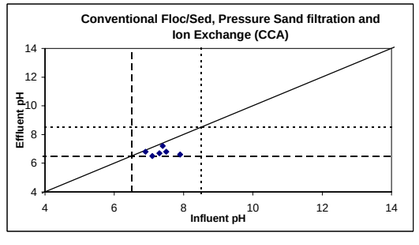


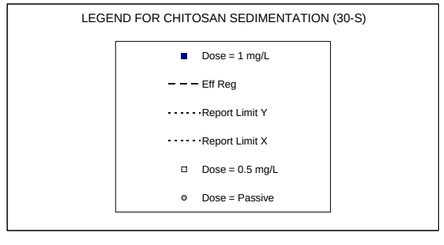












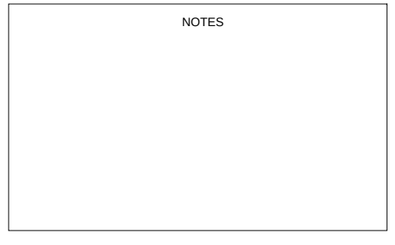
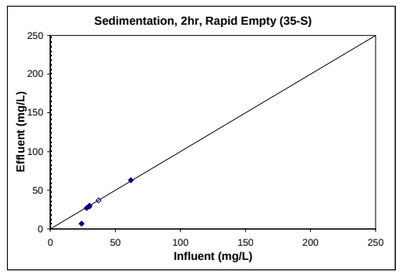
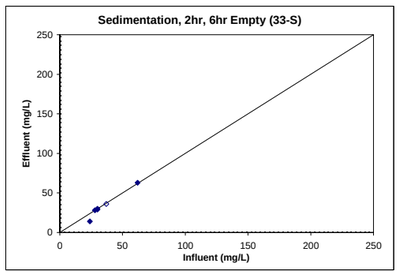
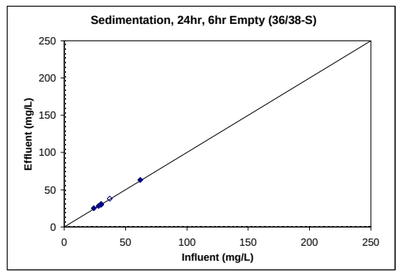


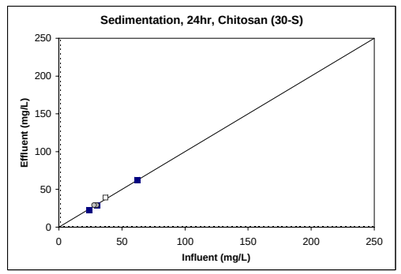
Figure 5-22. pH Value

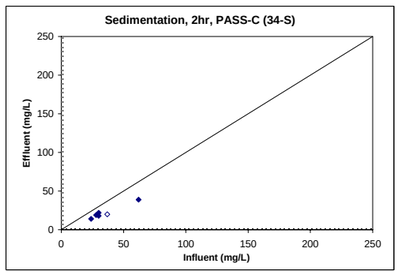
Alkalinity (Total)

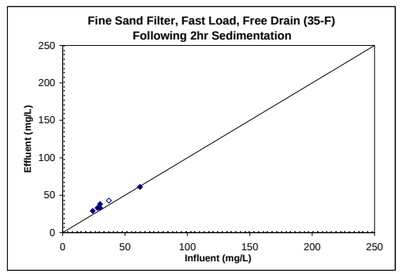


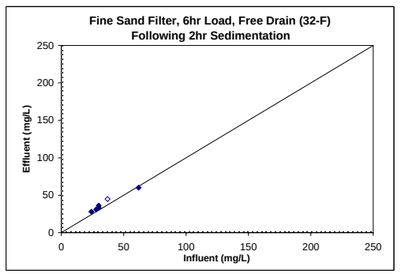


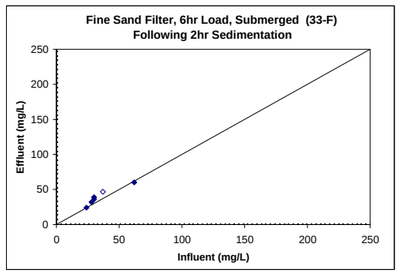


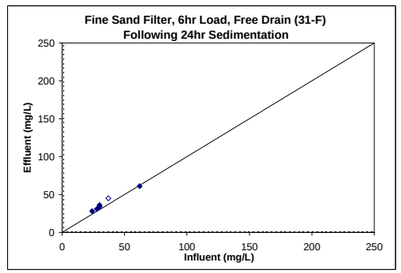


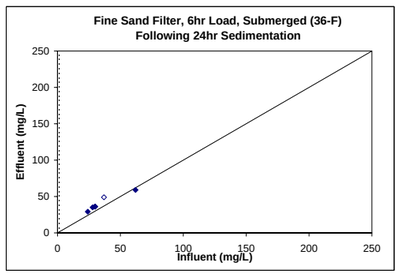


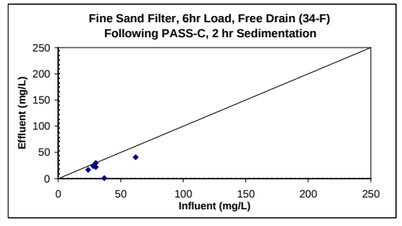


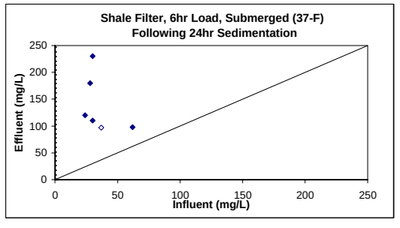


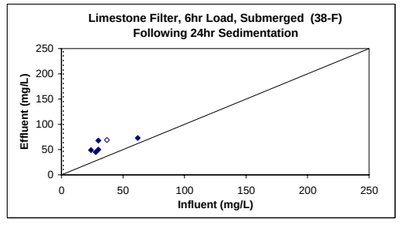


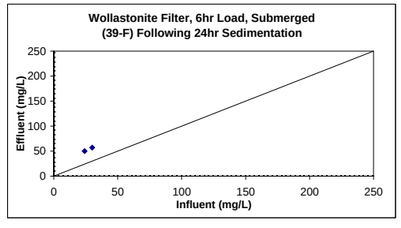


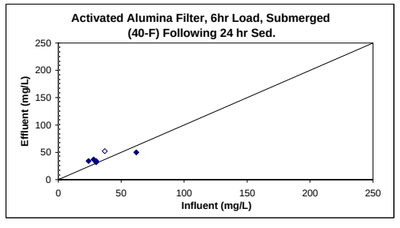


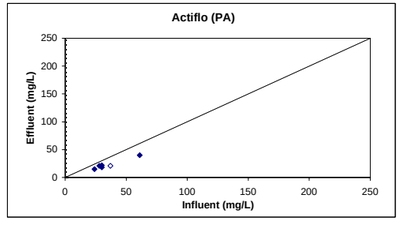


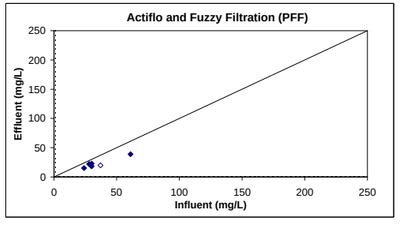


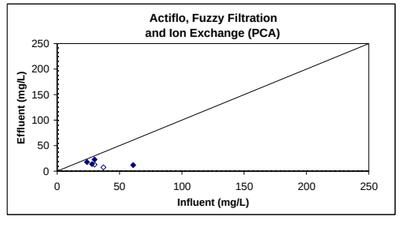


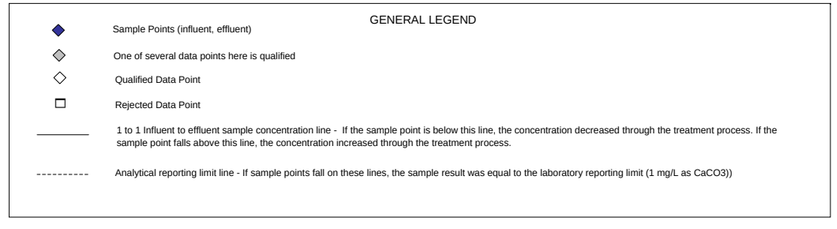


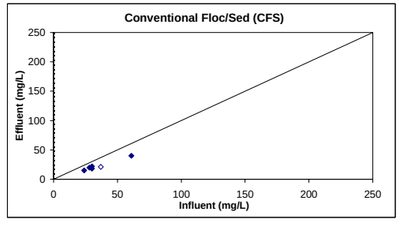


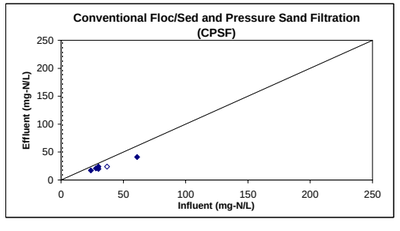


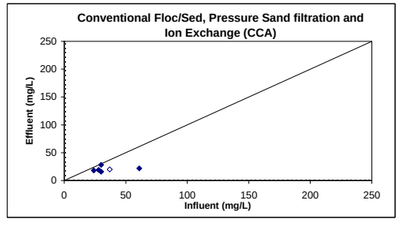


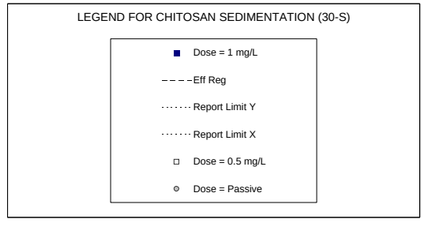












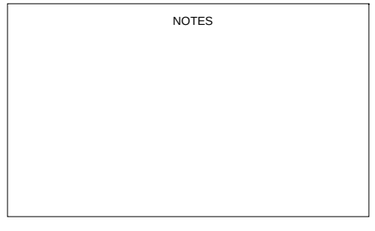
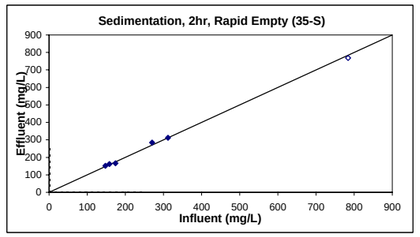
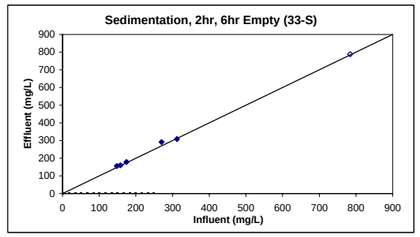
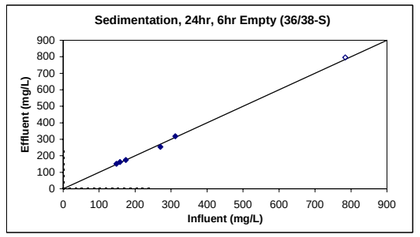


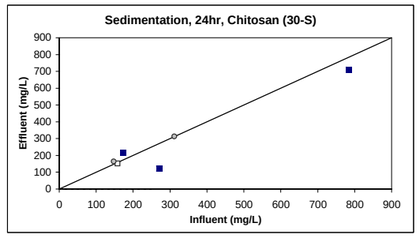
Figure 5-23. Alkalinity (Total)

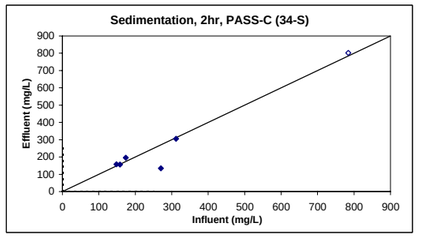
Total Dissolved Solids (TDS)

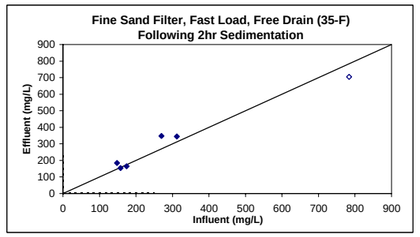


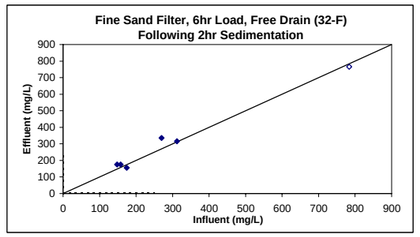


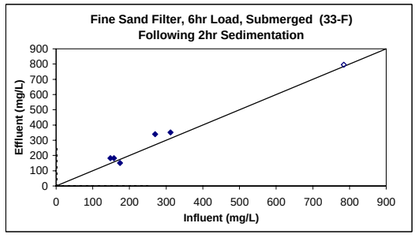


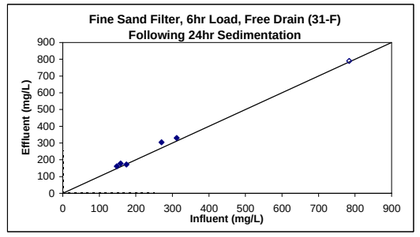


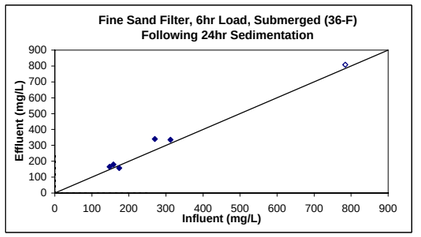


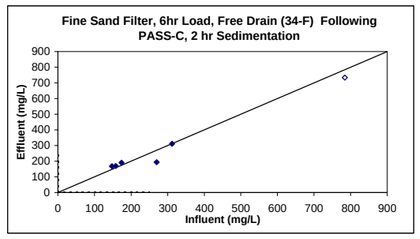


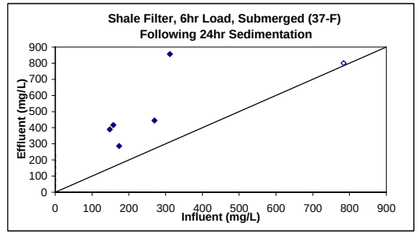


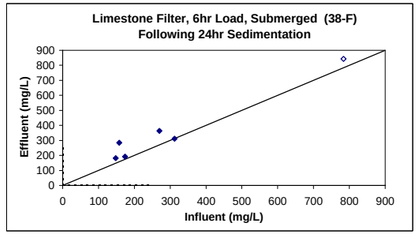


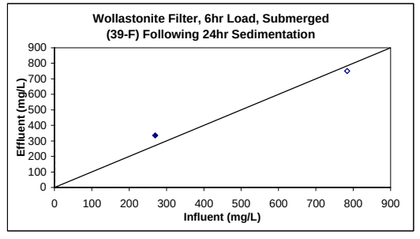


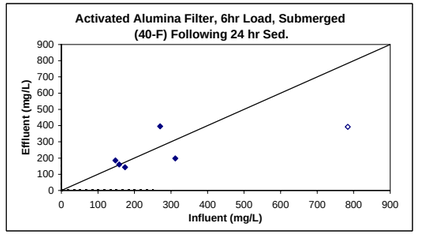


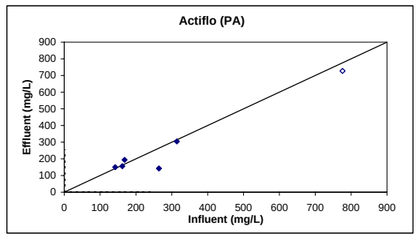


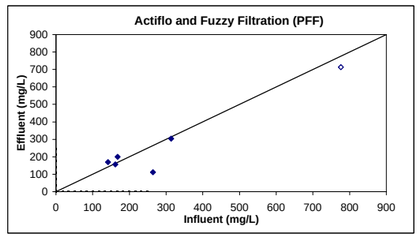


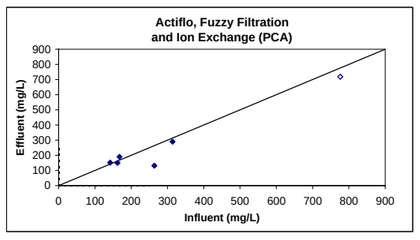






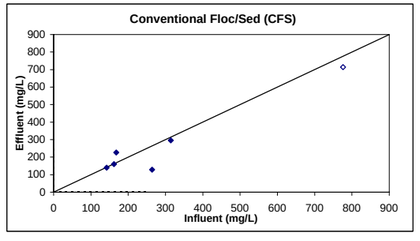


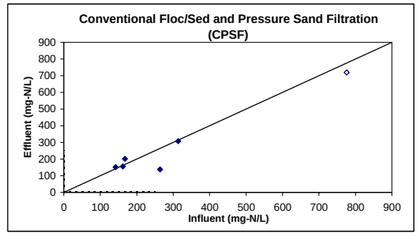


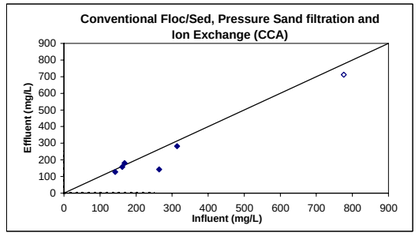


GENERAL LEGEND

- Sample Points (influent, effluent)
- One of several data points here is qualified
- Qualified Data Point
- Rejected Data Point
- 1 to 1 Influent to effluent sample concentration line - If the sample point is below this line, the concentration decreased through the treatment process. If the sample point falls above this line, the concentration increased through the treatment process.
- Analytical reporting limit line - If sample points fall on these lines, the sample result was equal to the laboratory reporting limit (1 mg/L)







LEGEND FOR CHITOSAN SEDIMENTATION (30-S)

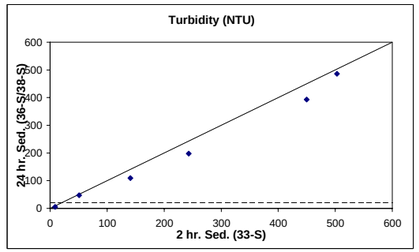
- Dose = 1 mg/L
- Eff Reg
- Report Limit Y
- Report Limit X
- Dose = 0.5 mg/L
- Dose = Passive

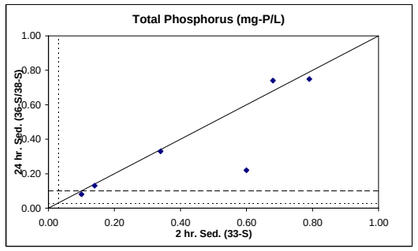
NOTES

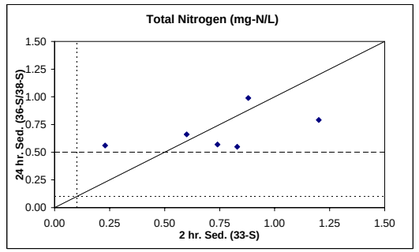
Figure 5-24. Total Dissolved Solids (TDS)

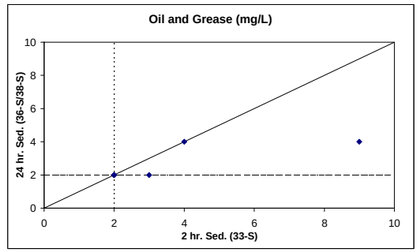
Sedimentation

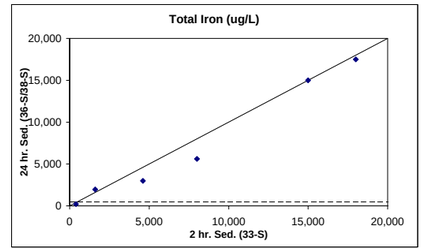
2 Hour vs. 24 Hour



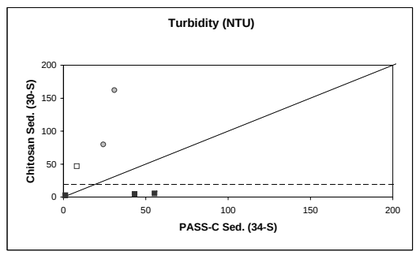


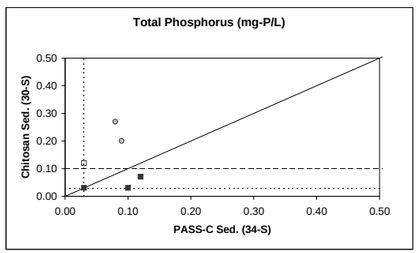


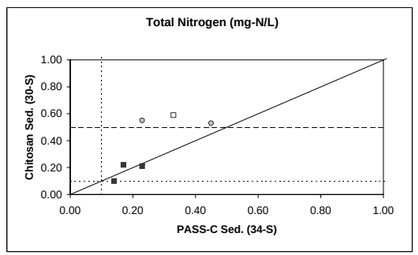


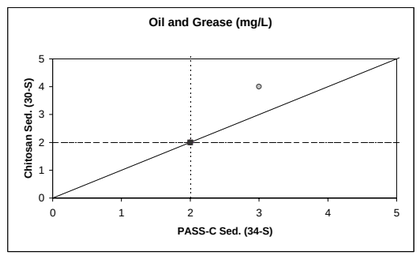


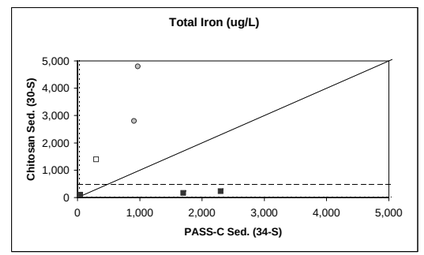
PASS-C (2 hr) vs. Chitosan (24 hr)

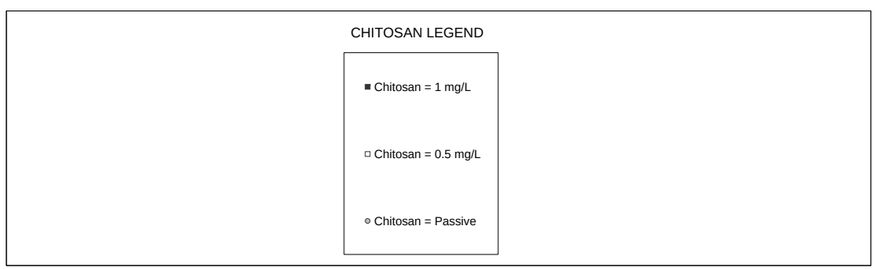












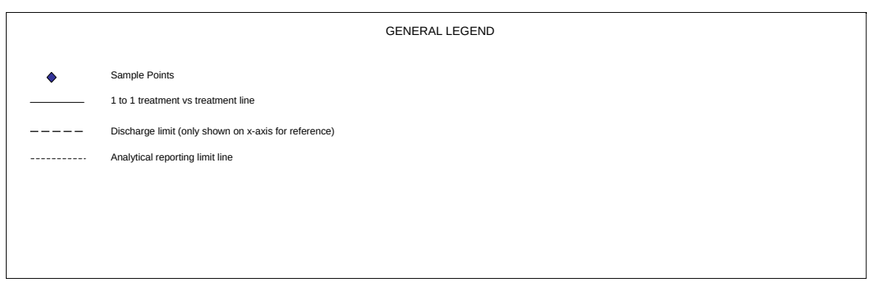
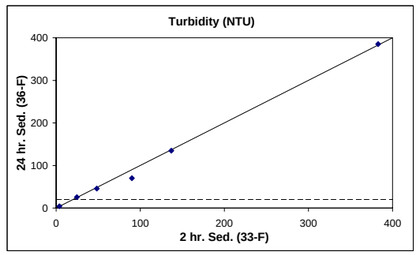
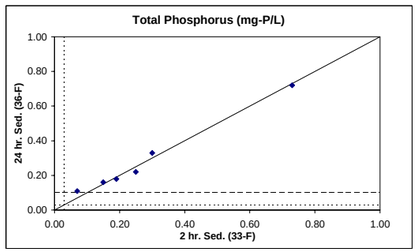


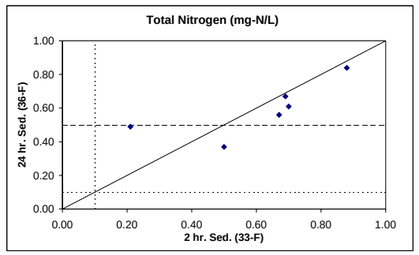
Figure 5-25. Sedimentation - 2 hour vs 24 hour and PASS-C vs Chitosan

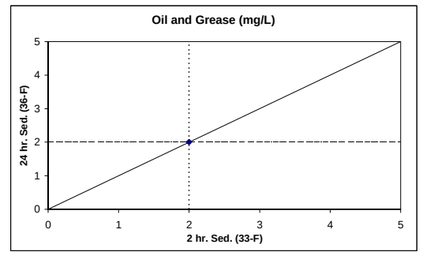
Sedimentation - 2 Hour vs. 24 Hours Followed by Filtration

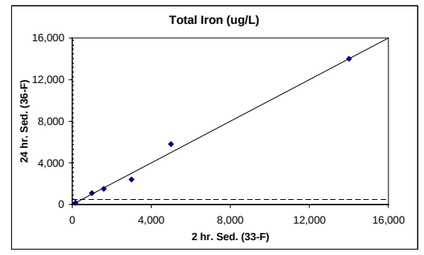
33-F vs 36-F, Slow Load, Fine Sand Filtration, Submerged



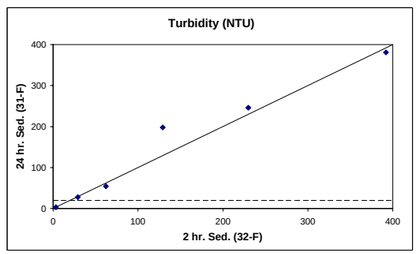


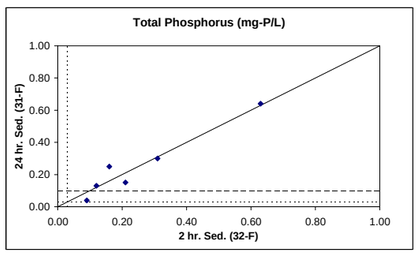


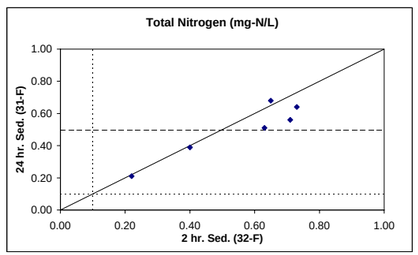


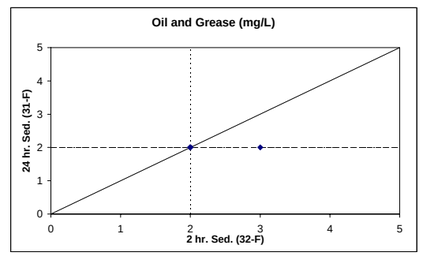


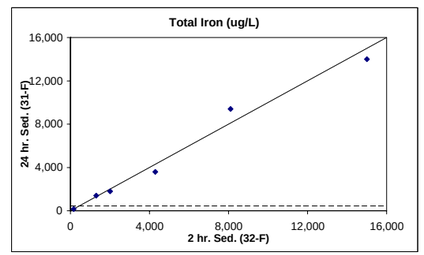
32-F vs 31-F, Slow Load, Fine Sand Filtration, Free Drain











NOTES

GENERAL LEGEND

- Sample Points
- 1 to 1 treatment vs treatment line
- Discharge limit (only shown on x-axis for refernece)
- Analytical reporting limit line

Figure 5-26. Sedimentation - 2 hour vs. 24 hour Followed by Filtration

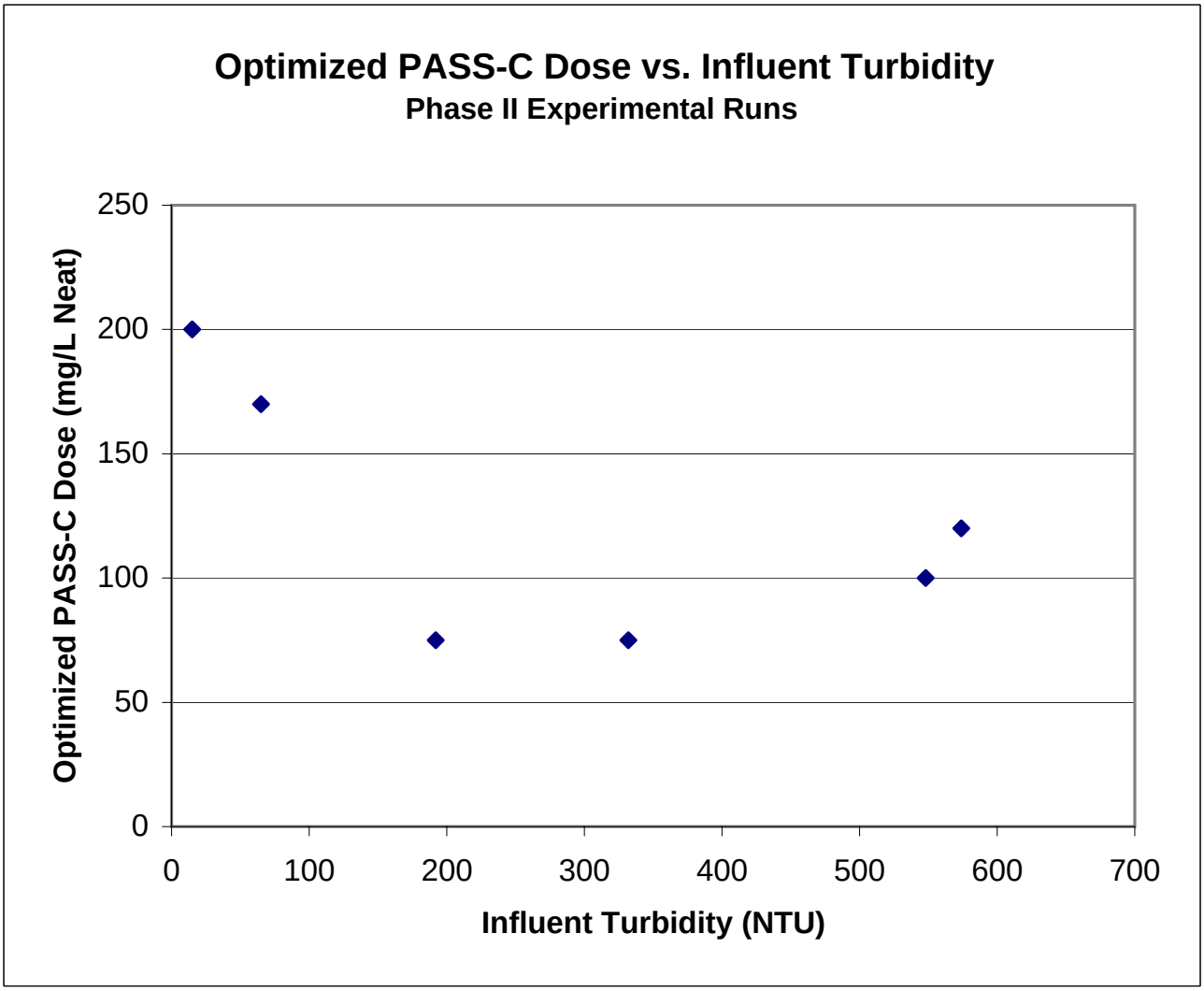
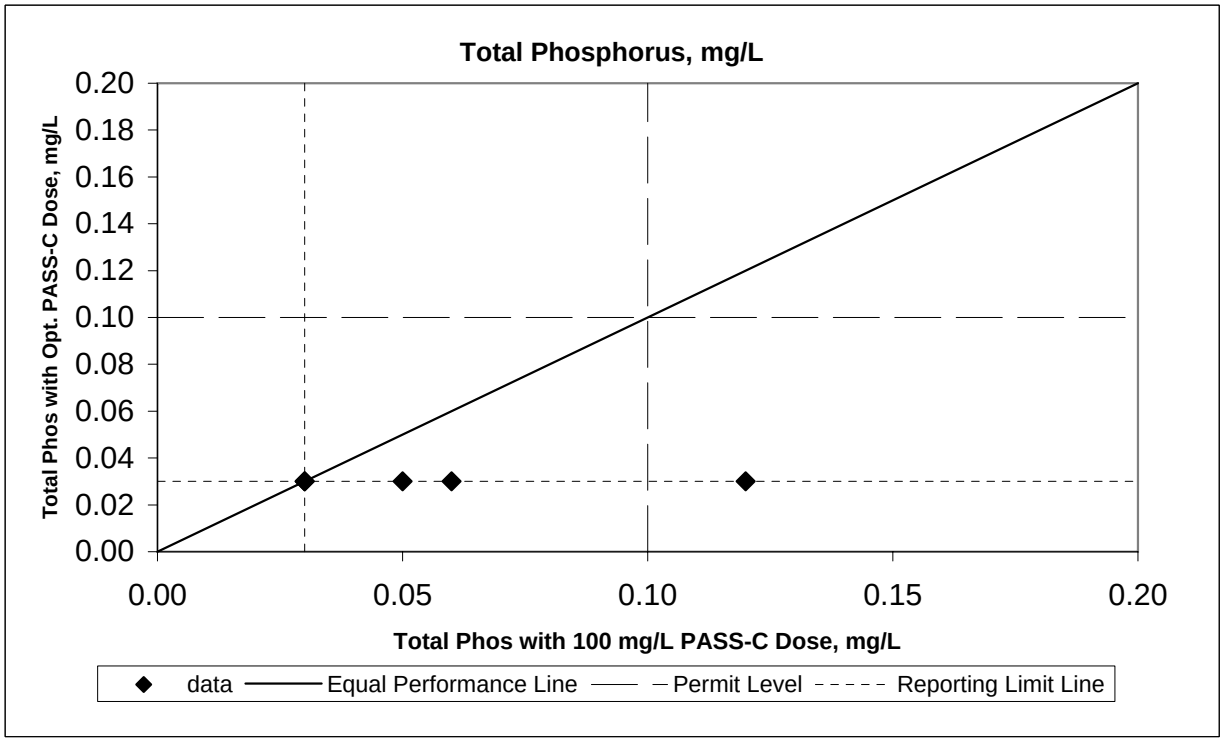


Figure 5-27. Optimized PASS-C Dose vs. Influent Turbidity

Chemical Dose - Fixed vs. Optimized
(Jar Test Data)



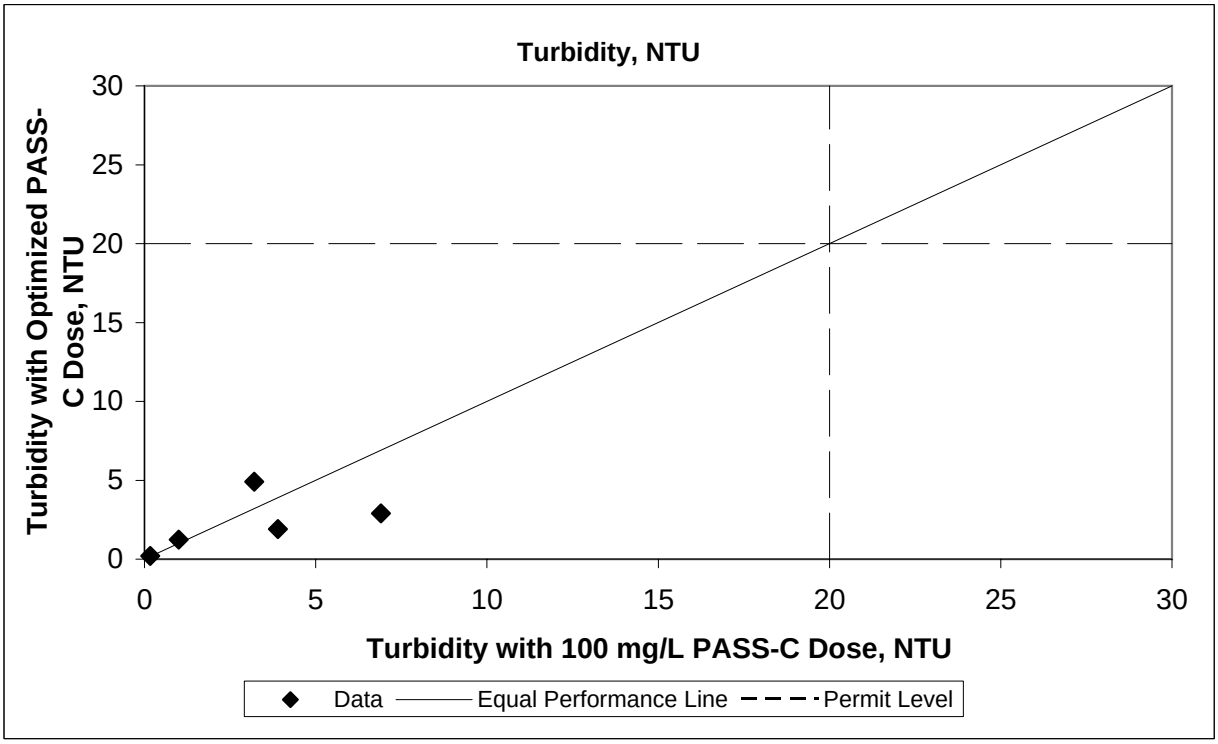
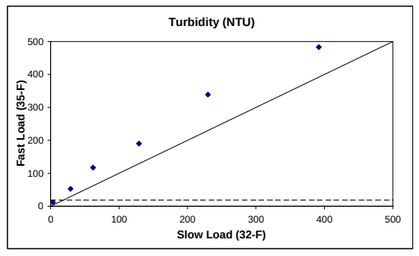
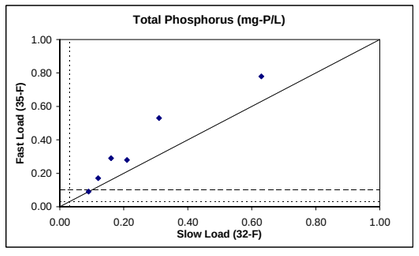


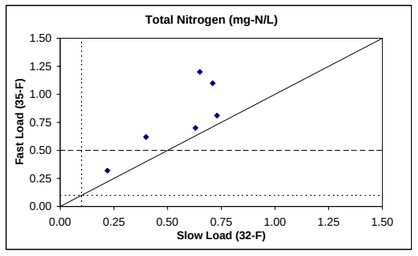
Figure 5-28. Chemical Dose - Fixed vs. Optimized (Jar Test Data)

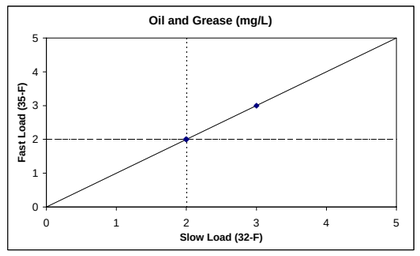
Filter Application Rate - Slow vs. Fast

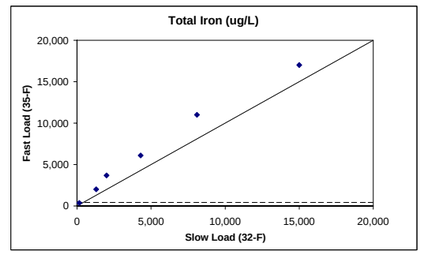
32-F vs 35-F, 2 hour sedimentation, Fine Sand Filtration, Free Drain











NOTES

Data points above the bisecting line indicate that the "Slow Load" condition was better.

Data points below the bisecting line indicate that the "Fast Load" condition was better.

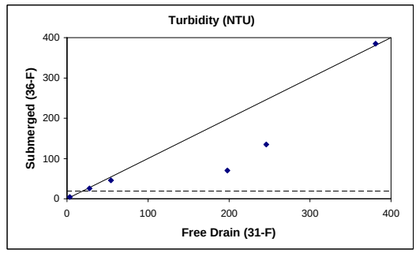
GENERAL LEGEND

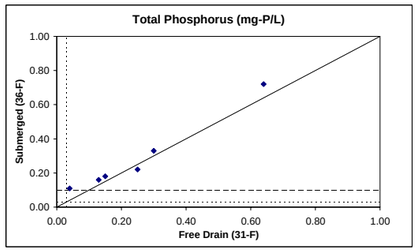
- Sample Points
- 1 to 1 treatment vs treatment line
- Discharge limit (only shown on the x-axis for reference)
- Analytical reporting limit line

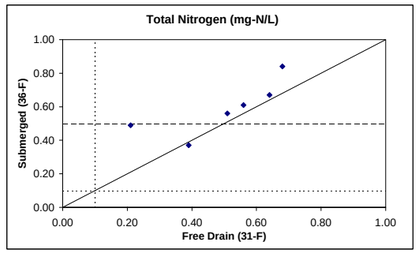
Figure 5-29. Filter Application Rate - Slow vs. Fast

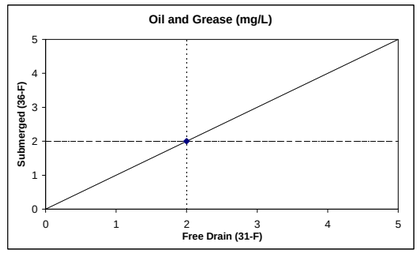
Filter Hydraulics - Submerged vs. Free Drain

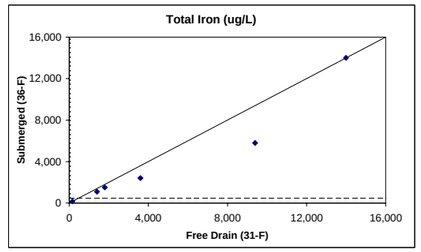
31-F vs 36-F, 24 Hour Sedimentation, Slow Load, Fine Sand Filtration



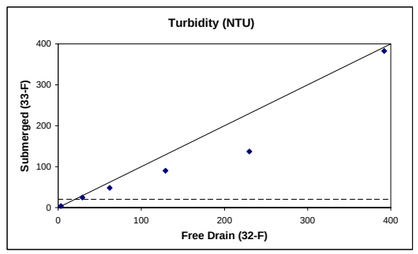


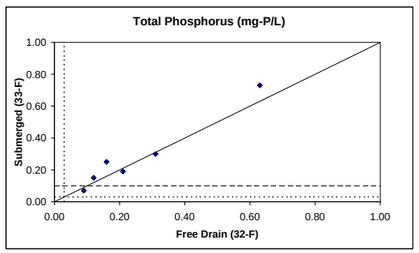


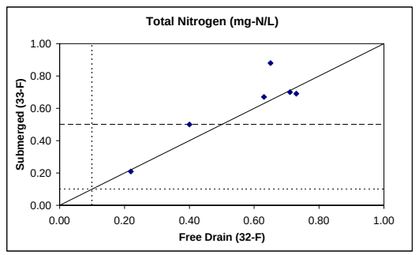


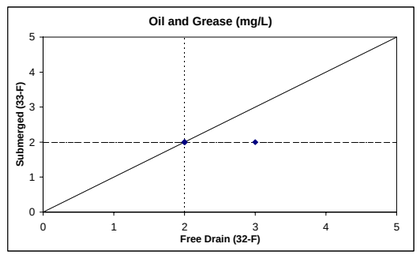


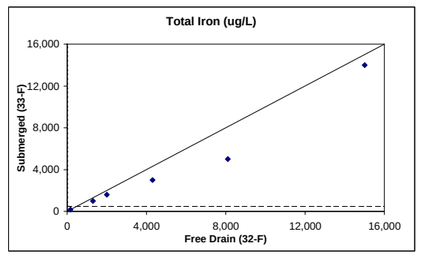
32-F vs 33-F, 2 Hour Sedimentation, Slow Load, Fine Sand Filtration











NOTES

Data points above the bisecting line indicate that the "Free Drain" condition was better.

Data points below the bisecting line indicate that the "Submerged Drain" condition was better.

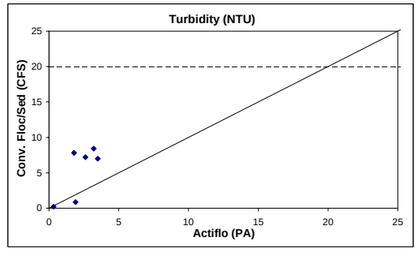
GENERAL LEGEND

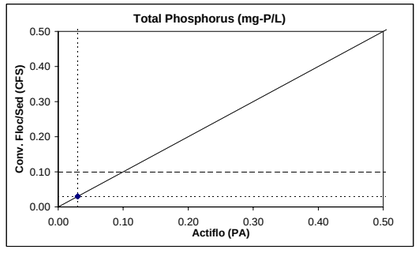
- Sample Points
- 1 to 1 treatment vs treatment line
- Discharge limit (only shown on x-axis for reference)
- Analytical reporting limit line

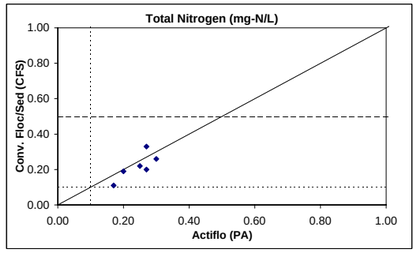
Figure 5-30. Filter Hydraulics - Submerged vs. Free Drain

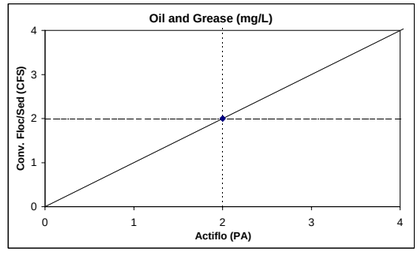
Mechanized Treatment - Proprietary vs. Non-Proprietary

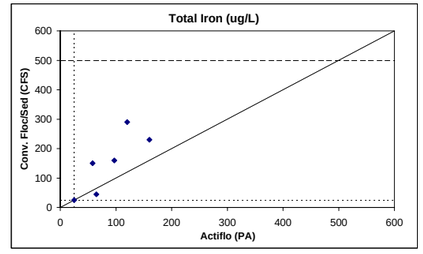
Actiflo vs. Conventional Floc/Sed



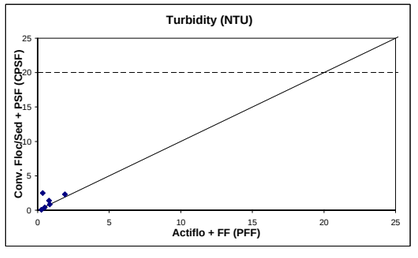


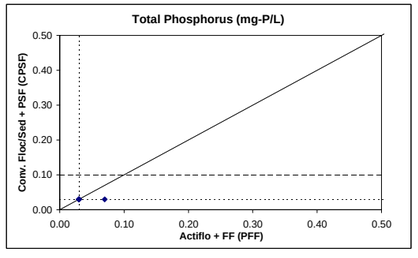


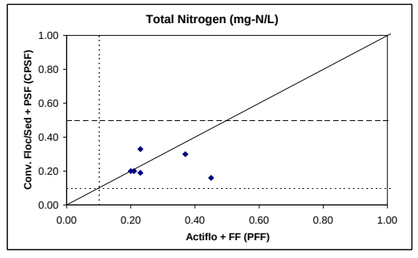


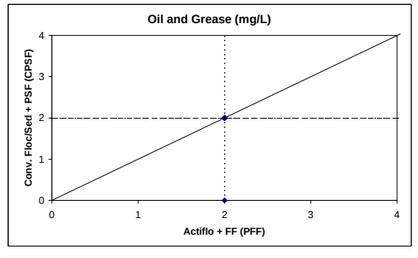


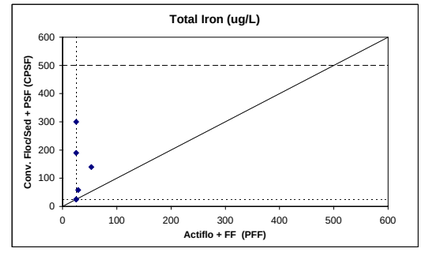
Actiflo + Fuzzy Filtration vs. Conventional Floc/Sed + Pressure Sand Filtration



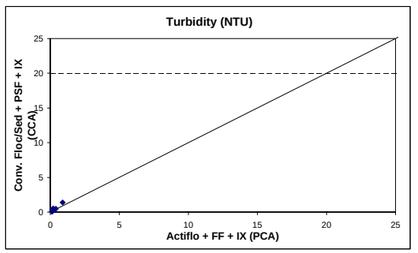


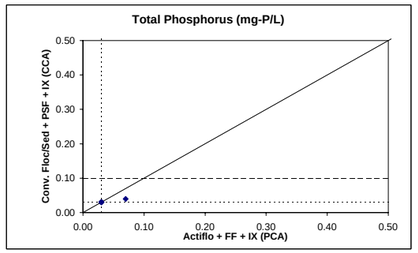


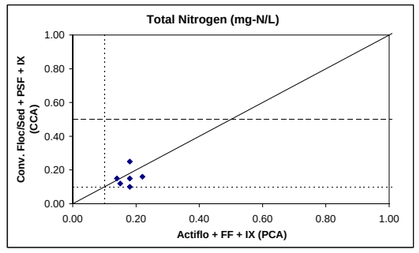


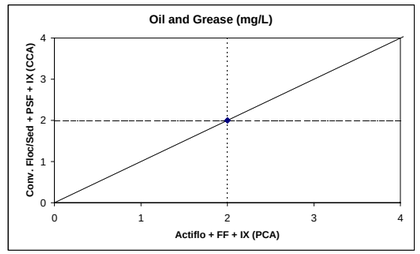


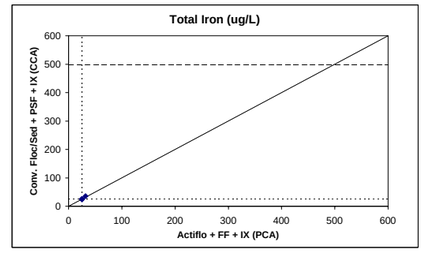
Actiflo + Fuzzy Filtration + Ion Exchange vs. Conventional Floc/Sed + Pressure Sand Filtration + Ion Exchange











NOTES

Data points above the bisecting line indicate that the proprietary systems performed better.

Data points below the bisecting line indicate that the conventional systems performed better.

GENERAL LEGEND

- Sample Points
- 1 to 1 treatment vs treatment line
- Discharge limit (only shown on the x-axis for reference)
- Analytical reporting limit line

Figure 5-31. Mechanized Treatment - Proprietary vs. Non-Proprietary

Influent/Effluent Graphs for the Fuzzy Filter(R) and Pressure Sand Filter

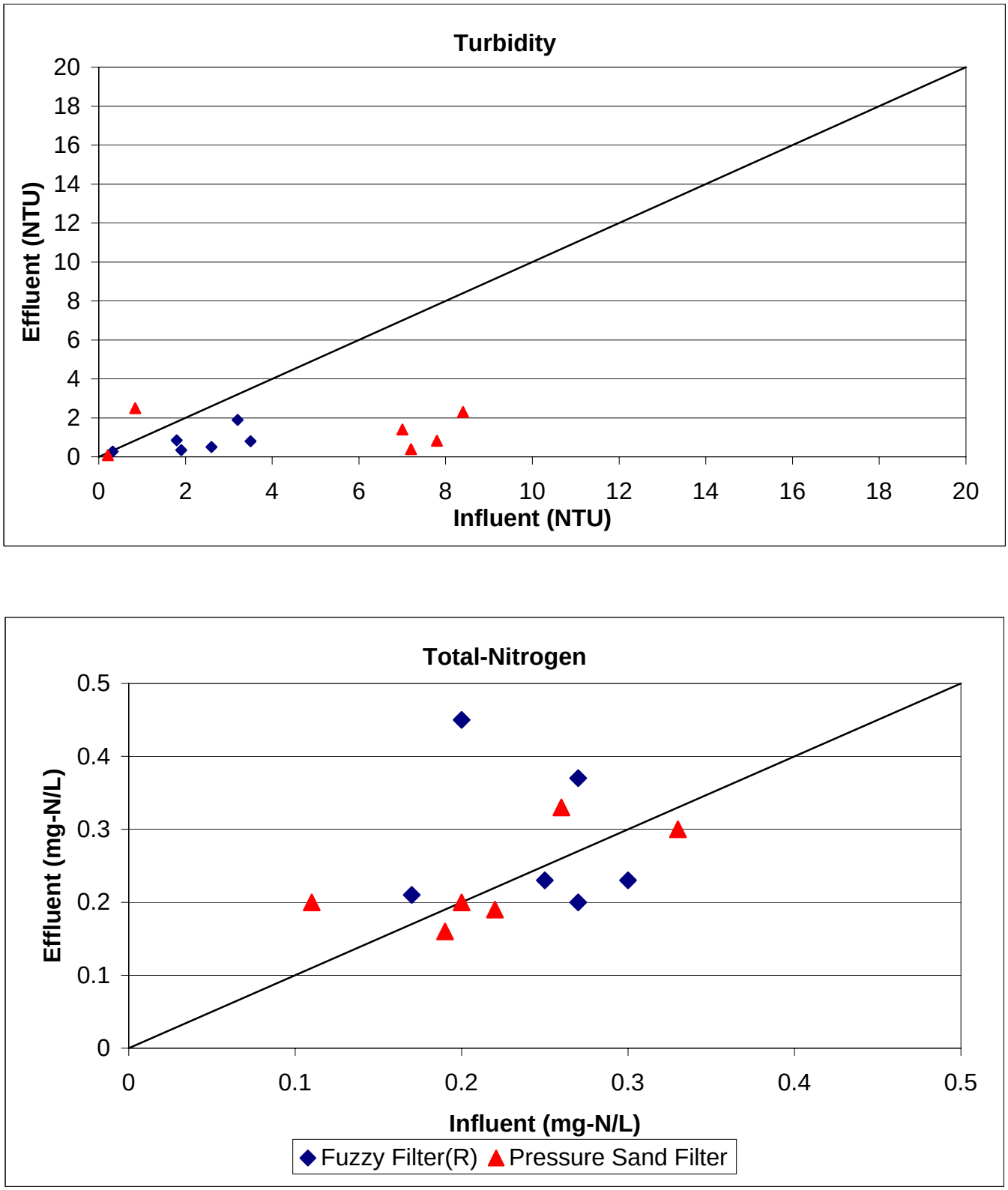


Figure 5-32. Influent/Effluent for Fuzzy Filter and Pressure Sand Filter

Chapter 6

Summary of Findings

Chapter 6 Summary of Findings

Key findings on the efficacy of the various treatment technologies tested in Phase II are summarized in this chapter. Suggestions for further small-scale testing of promising treatment technologies are also presented.

6.1 Summary of Findings

A summary of performance results for the treatment processes is presented in terms of percent removal in Table 6-1 and in terms of compliance with the Tahoe Basin discharge standards in Table 6-2.

Summarized in Table 6-1 are treatment performance results in terms of average percent removal (average of the six experimental runs for the 5 regulated constituents). Percent removal was calculated by subtracting the treatment unit effluent concentration divided by the influent concentration from 1 and then multiplying by 100. If the influent was less than the reporting limit (only the case for a few oil and grease samples) no value was included in the average. Removal down to the reporting limit was set equal to 100%. Negative removal values calculated for some of the individual run data points (i.e. when the data point falls above the 45-degree line in Figures 5-1 through 5-24) were included in the calculation of the average.

Summarized in Table 6-2 are treatment performance results in terms of the number of times that a process produced effluent that met the applicable Tahoe Basin surface or infiltration discharge limits. For example, performance given as "5 of 6" for a particular constituent indicates that discharge limits were met in five out of the six experimental runs carried out using that treatment. In each case the discharge limits were considered to have been met when the effluent concentration for a particular constituent was at or below the applicable discharge limit. Also shown in Table 6-2 are the number of times that influent storm water runoff itself met the applicable discharge limits. Storm water designated as "I-1, I-2" in the table is the influent to the non-mechanized systems (i.e., Day 1 of the experimental run); storm water designated as "I-3" is influent to the mechanized systems (Day 2 of the run).

6.1.1 Non-Mechanized Sedimentation Processes

Sedimentation Without Chemical Addition

Sedimentation (2-hour or 24-hour, without chemical addition) did not produce effluents that consistently met the surface water discharge standards for any of the regulated constituents (Table 6-2). Infiltration standards were consistently met for total phosphorus (total-P), total nitrogen (total-N) and oil and grease (O&G), but for these constituents the influent concentrations were already at or below the discharge standards. With the exception of total nitrogen, mean removal efficiencies for the 24-hour sedimentation units (Units 36/38-S in Table6-1) were 11 to 31 percentage points higher than those achieved by the 2-hour sedimentation units (Unit 33-S).

Table 6-1. Summary of Phase II Treatment System Performance - Average Percent Removal

SEDIMENTATION PROCESSES						Average Percent Removal				
Unit	**Chemical**	**Sed. Time**	**Precedes Filter Containing**	**Empty Cycle**	**Notes**	**Turb**	**Tot-P**	**Tot-N**	**O&G**	**Fe-T**
35-S	none	2-hr.	Fine Sand	"Fast"		7	6	9	32	13
33-S	none	2-hr.	Fine Sand	6 hr.		27	13	8	41	30
36/38-S	none	24-hr.	Fine Sand & Limestone	6 hr.	average of the 2 units	39	27	-7	72	41
30-S	Chitosan	24-hr.	None	6 hr.	last 3 runs	94	97	64	100	95
34-S	PASS-C	2-hr.	Fine Sand	6 hr.	all runs	90	84	63	93	90
FILTRATION PROCESSES						**Average Percent Removal**				
Unit	**Chemical**	**Sed. Time**	**Filter Media**	**Filter Loading**	**Outlet**	**Turb**	**Tot-P**	**Tot-N**	**O&G**	**Fe-T**
35-F	none	2-hr.	Fine Sand	"Fast"	Free	31	24	-4	78	38
32-F	none	2-hr.	Fine Sand	6 hr.	Free	60	43	28	90	58
33-F	none	2-hr.	Fine Sand	6 hr.	Sub.	66	39	22	95	67
31-F	none	24-hr.	Fine Sand	6 hr.	Free	58	53	34	100	58
36-F	none	24-hr.	Fine Sand	6 hr.	Sub.	66	34	10	100	66
34-F	PASS-C	2-hr.	Fine Sand	6 hr.	Free	99	76	63	100	100
37-F	none	24-hr.	Exp. Shale	6 hr.	Sub.	99	82	79	76	100
38-F	none	24-hr.	Limestone	6 hr.	Sub.	82	74	56	100	84
39-F	none	24-hr.	Wollastonite	6 hr.	Sub.	64	59	61	100	61
40-F	none	24-hr.	Activated Alumina	6 hr.	Sub.	99	99	75	100	99
MECHANIZED PROCESSES						**Average Percent Removal**				
Unit	Treatment Units					**Turb**	**Tot-P**	**Tot-N**	**O&G**	**Fe-T**
PA	Actiflo®					98	93	70	100	99
PFF	Actiflo® + Fuzzy Filter®					100	93	63	100	100
PCA	Actiflo® + Fuzzy Filter® + Ion Exchange					100	83	79	100	100
CFS	Conventional Floc/Sed					98	99	73	100	98
CPSF	Conventional Floc/Sed + Pressure Sand Filtration					99	100	72	100	98
CCA	Conventional Floc/Sed + Pressure Sand Filtration + IX					100	90	80	100	100

Table Abbreviations – Turb = turbidity, Tot-P = total phosphorus, Tot-N = total nitrogen, O&G = oil and grease, Fe-T = total iron, Sub. = Submerged, IX = Ion Exchange.

Table 6-2. Summary of Phase II Treatment System Performance - Removal Relative to Numerical Permit Limits

SEDIMENTATION PROCESSES						Meets Infiltration Standard					Meets Surface Water Discharge Standard				
Unit	**Chemical**	**Sed. Time**	**Precedes Filter**	**Empty Cycle**	**Notes**	**Turb**	**Tot-P**	**Tot-N**	**O&G**	**Fe-T**	**Turb**	**Tot-P**	**Tot-N**	**O&G**	**Fe-T**
I-1, I-2	Day 1 Influent, avg.		N/A	N/A		3 of 6	6 of 6	6 of 6	6 of 6	2 of 6	1 of 6	0 of 6	1 of 6	3 of 6	0 of 6
35-S	none	2-hr.	Fine Sand	"Fast"		3 of 6	6 of 6	6 of 6	6 of 6	2 of 6	1 of 6	0 of 6	1 of 6	3 of 6	0 of 6
33-S	none	2-hr.	Fine Sand	6 hr.		3 of 6	6 of 6	6 of 6	6 of 6	2 of 6	1 of 6	0 of 6	1 of 6	3 of 6	1 of 6
36/38-S	none	24-hr.	Fine Sand & Limestone	6 hr.	Avg, 2 units	4 of 6	6 of 6	6 of 6	6 of 6	3 of 6	1 of 6	1 of 6	0 of 6	4 of 6	1 of 6
30-S	Chitosan	24-hr.	Fine Sand	6 hr.	Last 3 runs	3 of 3	3 of 3	3 of 3	3 of 3	3 of 3	3 of 3	3 of 3	3 of 3	3 of 3	3 of 3
34-S	PASS-C	2-hr.	Fine Sand	6 hr.		6 of 6	6 of 6	6 of 6	6 of 6	6 of 6	2 of 6	5 of 6	6 of 6	5 of 6	2 of 6
FILTRATION PROCESSES						**Meets Infiltration Standard**					**Meets Surface Water Discharge Standard**				
Unit	**Chemical**	**Sed. Time**	**Filter Media**	**Filter Load**	**Outlet**	**Turb**	**Tot-P**	**Tot-N**	**O&G**	**Fe-T**	**Turb**	**Tot-P**	**Tot-N**	**O&G**	**Fe-T**
35-F	none	2-hr.	Fine Sand	"Fast"	Free	5 of 6	6 of 6	6 of 6	6 of 6	3 of 6	1 of 6	1 of 6	1 of 6	4 of 6	1 of 6
32-F	none	2-hr.	Fine Sand	6 hr.	Free	6 of 6	6 of 6	6 of 6	6 of 6	3 of 6	1 of 6	1 of 6	2 of 6	5 of 6	1 of 6
33-F	none	2-hr.	Fine Sand	6 hr.	Submerged	5 of 6	6 of 6	6 of 6	6 of 6	4 of 6	1 of 6	1 of 6	2 of 6	6 of 6	1 of 6
31-F	none	24-hr.	Fine Sand	6 hr.	Free	4 of 6	6 of 6	6 of 6	6 of 6	4 of 6	1 of 6	2 of 6	2 of 6	6 of 6	1 of 6
36-F	none	24-hr.	Fine Sand	6 hr.	Submerged	5 of 6	6 of 6	6 of 6	6 of 6	4 of 6	1 of 6	0 of 6	2 of 6	6 of 6	1 of 6
34-F	PASS-C	2-hr.	Fine Sand	6 hr.	Free	6 of 6	6 of 6	6 of 6	6 of 6	6 of 6	6 of 6	6 of 6	6 of 6	6 of 6	6 of 6
37-F	none	24-hr.	Exp. Shale	6 hr.	Submerged	6 of 6	6 of 6	6 of 6	6 of 6	6 of 6	6 of 6	5 of 6	6 of 6	5 of 6	6 of 6
38-F	none	24-hr.	Limestone	6 hr.	Submerged	5 of 6	6 of 6	6 of 6	6 of 6	5 of 6	4 of 6	4 of 6	5 of 6	6 of 6	4 of 6
39-F	none	24-hr.	Wollastonite	6 hr.	Submerged	1 of 2	2 of 2	2 of 2	2 of 2	1 of 2	0 of 2	0 of 2	1 of 2	2 of 2	0 of 2
40-F	none	24-hr.	Activated Alumina	6 hr.	Submerged	6 of 6	6 of 6	6 of 6	6 of 6	6 of 6	5 of 6	6 of 6	6 of 6	6 of 6	5 of 6
MECHANIZED PROCESSES						**Meets Infiltration Standard**					**Meets Surface Water Discharge Standard**				
Unit	**Process**					**Turb**	**Tot-P**	**Tot-N**	**O&G**	**Fe-T**	**Turb**	**Tot-P**	**Tot-N**	**O&G**	**Fe-T**
I-3	Day 2 Influent					3 of 6	5 of 6	6 of 6	6 of 6	2 of 6	1 of 6	1 of 6	1 of 6	3 of 6	0 of 6
PA	Actiflo®					6 of 6	6 of 6	6 of 6	6 of 6	6 of 6	6 of 6	6 of 6	6 of 6	6 of 6	6 of 6
PFF	Actiflo® + Fuzzy Filter®					6 of 6	6 of 6	6 of 6	6 of 6	6 of 6	6 of 6	6 of 6	6 of 6	6 of 6	6 of 6
PCA	Actiflo® + Fuzzy Filter® + Ion Exchange					6 of 6	6 of 6	6 of 6	6 of 6	6 of 6	6 of 6	6 of 6	6 of 6	6 of 6	6 of 6
CFS	Conventional Floc/Sed					6 of 6	6 of 6	6 of 6	6 of 6	6 of 6	6 of 6	6 of 6	6 of 6	6 of 6	6 of 6
CPSF	Conventional Floc/Sed + Pressure Sand Filtration					6 of 6	6 of 6	6 of 6	6 of 6	6 of 6	6 of 6	6 of 6	6 of 6	6 of 6	6 of 6
CCA	Conventional Floc/Sed + Pressure Sand Filtration + Ion Exchange					6 of 6	6 of 6	6 of 6	6 of 6	6 of 6	6 of 6	6 of 6	6 of 6	6 of 6	6 of 6

Sedimentation with PASS-C®

Sedimentation with optimized PASS-C® addition (2-hour sedimentation, Unit 34-S) was generally successful at meeting the surface discharge limits for total-P, total-N and O&G (5 or 6 out of 6 runs). It was unsuccessful at consistently producing an effluent that complied with the surface water turbidity and total-Fe limits, even though removals of 90 percent (Table 6-1) were observed. As shown in Figures 5-1 and 5-17, effluent concentrations for turbidity and total-Fe were close to the surface water effluent limits.

Sedimentation with Liquid Chitosan

When dosed at 1 mg/L of the Liqui-Floc™ chitosan product, sedimentation following chitosan addition (24-hour sedimentation, Unit 30-S) successfully produced effluents that complied with both the surface water and infiltration standards in all 3 runs that the target dose was attained. For these three runs, performance was somewhat better than that for sedimentation with PASS-C® addition. Except for oil and grease, removal rates were the same or slightly higher (1 to 13 percentage points) than those observed in sedimentation using PASS-C®. It should be emphasized that the chitosan results are based on only three runs.

6.1.2 Non-Mechanized Filtration Following Sedimentation

Sedimentation and Fine Sand Filtration without Chemical Addition

Without chemical treatment, none of the sedimentation and fine sand filtration systems consistently met the surface water discharge standards. These results are comparable to those found in Phase I for fine sand filtration systems. As discussed below, process modifications such as reducing the filter loading and submerging the media improved performance, but not enough to consistently meet the surface water discharge limits. Infiltration discharge limits were met, but as noted previously, the influent storm water often met these standards as well.

Effect of Sedimentation Time: Increasing sedimentation time from 2- to 24-hours had little or no effect on overall treatment in sedimentation/filtration systems (see Tables 6-1 and 6-2, Unit 32-F compared with 31-F and Unit 33-F compared with 36-F). Only slight improvement in water quality was realized by settling the storm water for an additional 22 hours. Based on the fine sand filter data, the particle make-up of the storm water after sedimentation was essentially the same after 2- or 24-hours of settling time (Figure 5-25). Sand filtration may require a prolonged sedimentation period (>24 hours) or chemical enhancements to improve performance.

Effect of Loading Rate: Tests were performed to compare the performances of "fast load" and "slow load" filters. Fast load filters (Unit 35-F and all of the fine sand filters in Phase I) allow the water to flow through the media at whatever rate the hydraulic conductivity allowed. Slow loaded filters are simply loaded using a small pump at the controlled rate of 3 feet in 6 hours (like Unit 32-F, and others). Slow loading allowed for one additional total nitrogen and oil and grease effluent value to attain compliance with the surface discharge limits (Table 6-2). The fast loaded filter (Unit 35-F) removed 31% of the turbidity, 24% of the total phosphorus, 78% oil and grease, 22% of the total iron, but increased the average total nitrogen level in the effluent (-4% total nitrogen removal). In comparison, the slow loaded filter (Unit 32-F) removed 60% of the

turbidity, 43% of the total phosphorus, 28% total nitrogen, 90% oil and grease, and 58% of the total iron, which on the average is approximately 20 percent better than the fast loaded unit.

Free-Draining vs. Submerged Media: Fine sand filters with submerged media (Units 36-F and 33-F) were 7% better at the removal of turbidity than filters with free-draining media (Units 31-F and 32-F). Additionally, the fine sand filters with submerged media were 8% better at total iron removal than similar filters with free-draining media (see Figure 5-30). However, the free draining sand filters were 3-19% better at removing total phosphorus and 6 to 24% better at total nitrogen removal. Both the free-draining and submerged hydraulic sand filters had almost identical performance with respect to meeting the surface water discharge limits (Table 6-2).

Sedimentation and Fine Sand Filtration with PASS-C®

Fine sand filtration following sedimentation with optimized PASS-C® addition (34-F) met all the surface water and infiltration discharge standards. This process performed consistently better than the similar process tested in Phase I. However, there were two key differences in operation between Phase I and Phase II. In Phase I, a constant PASS-C® dose of 100 mg/L was used, while in Phase II, the dose was varied from 75 to 200 mg/L based on jar testing of the influent for each run. In Phase I, the filter was "fast-loaded", while in Phase II, the filter was "slow-loaded". Based on the data from the two phases, it appears that optimizing PASS-C® addition and reducing filter loading rates may improve treatment.

Sedimentation and Expanded Shale Filtration

Expanded shale filtration following 24-hour sedimentation (37-F, no chemical) produced effluents that consistently met the infiltration discharge limits and met the surface discharge limits for all constituents in all runs except for O&G in Run 7 and total-P in Run 11.

Although effectively removing the regulated constituents, filtration with expanded shale, often produced an effluent with pH greater than 11 and dissolved aluminum concentrations as high as 500 µg/L. In addition, total dissolved solids concentrations increased by about 200 mg/L and electrical conductivity increased by about 400 µmhos/cm.

Sedimentation and Activated Alumina Filtration

Filtration through activated alumina following 24-hour sedimentation (40-F, no chemical) produced effluents that consistently met the infiltration discharge limits and met the surface discharge limits for all constituents in all runs except for turbidity and total-Fe in Experimental Run 12.

Filtration through activated alumina often resulted in elevated pH and dissolved aluminum in the effluent. Although the increase in pH was generally smaller than that measured for expanded shale filtration, effluent pH values were typically around 9. Dissolved aluminum concentrations in the filter effluent ranged from 280 to 560 µg/L.

Sedimentation and Limestone Filtration

Effluent quality from filtration with limestone following 24-hour sedimentation (38-F, no chemical) was somewhat inconsistent. This process produced effluent that met all of the infiltration and surface water discharge standards in the first four runs. In the last two runs, most of the surface water discharge requirements were not met. Whether this was due to somewhat higher influent concentrations in the last two runs, or a degradation in the filter's capabilities is not known.

Sedimentation and Wollastonite Filtration

Wollastonite filtration (Unit 39-F) was tested in only two runs in Phase II, with mixed results. This process was successful at meeting the O&G surface water discharge standard, partially successful (1 of 2 runs) at meeting the total nitrogen standard, and unsuccessful at meeting the turbidity and total phosphorus standards.

Effluent pH values were elevated to about pH 9, but the wollastonite did not appear to contribute any significant amount of dissolved aluminum to the effluent. It needs to be emphasized that these results are based on only two experimental runs.

6.1.3 Mechanized Treatment Systems

Proprietary Treatment

The proprietary treatment system consisted of a batch Actiflo® unit (with optimized PASS-C®, LT25 polymer dose and microsand addition) followed by the Fuzzy Filter® and ion exchange. This system produced effluents that met both the infiltration and surface water limits for all constituents in every run. What is noteworthy about this treatment train is that the Actiflo® (PA) process could by itself produce an effluent that consistently met the surface water discharge limits (this was not observed in Phase I where the influent storm water contained substantially more nitrogen and phosphorus). Subsequent filtration (PFF) and ion exchange (PCA) treatment were not necessary for compliance. Although not required for compliance, the Fuzzy Filter® did provide additional turbidity and total iron reduction and ion exchange provided additional total nitrogen reduction.

Conventional Treatment

The conventional mechanized system consisted of a batch clarification unit (with optimized PASS-C® and LT25 polymer dose, but no microsand) followed by pressure sand filtration and ion exchange. This system also met the surface water discharge limits for all constituents in every run. Although meeting the legal standards (Table 6-2) and having almost the same percent removals (Table 6-1), the treatment performance was not quite as good as the proprietary Actiflo® with respect to turbidity and iron removal (see Figure 5-31). The conventional system was slightly superior to the proprietary system in tot-N and tot-P removals. As in the proprietary system, most treatment occurred in the batch clarification stage (CFS), and subsequent filtration (CPSF) and ion exchange (CCA) treatment were not necessary for compliance. Although not

required for compliance, the pressure sand filter provided additional turbidity removal, and the ion exchange unit provided additional total iron removal.

6.2 Overall Treatment Performance Rankings

With respect to the goals of this project, the abilities of the various treatment systems to meet the requirements for surface water discharge within the Tahoe Basin are paramount. Treatment unit performance can be ranked by counting the number of times that the treatment unit effluent complied with the surface water discharge limits for the five regulated parameters (turbidity, total phosphorus, total nitrogen, oil and grease, and total iron) in the six experimental runs. Presented in Table 6-3 is such a ranking. Additionally, performance can be evaluated by calculating percent removals (see Table 6-1) for the five regulated parameters and then averaging these values (see Table 6-3, "Average Percent Removal" column). The average percent removal is used as a secondary ranking criterion in Table 6-3.

It should be noted that in choosing a treatment technology, performance with respect to legal discharge limits and removal efficiencies is a necessary but not entirely sufficient basis for process selection. Feasibility, reliability, longevity, cost, and water quality effects (like elevated pH and dissolved aluminum) must be considered. The full determination of feasibility and cost are beyond the scope of this study, which is intended only to determine "proof-of-concept". Other water quality effects associated with the various treatment options are listed in the last column of Table 6-3.

As indicated in Table 6-3, both mechanized treatment systems, chitosan dosed 24-hour sedimentation, and fine sand filtration following chemically enhanced 2-hour sedimentation (PASS-C®) met all of the surface discharge requirements in all runs tested. All of these treatment technologies involve the use of chemicals to facilitate treatment.

Chitosan-enhanced sedimentation was able to meet the surface discharge limits for all three runs in which it was tested at a 1 mg/L dose. The three previous runs in which the target dose was not attained are not reflected in the ranking indicated in Table 6-3. Although only three runs were accomplished at the target dose, there is no reason to doubt performance over a larger number of observations.

The activated alumina and expanded shale filters (following 24 hour sedimentation without chemicals) were able to attain compliance 28 of 30 times. Furthermore, the activated alumina filter system had some of the highest percent removals observed in Phase II. However, increased aluminum and elevated pH in the effluent are significant issues with these filter media.

The limestone and Wollastonite media (filtration following 24 hour sedimentation without chemicals) were not as effective as the activated alumina and expanded shale media in meeting the surface water discharge standards. The limestone system met the standards 23 of 30 times, while the Wollastonite system met the standards only 3 of 10 times (only two runs for Wollastonite). Elevated pH was an issue with both of these media.

Sedimentation without chemicals and sedimentation without chemicals followed by fine sand filtration (various configurations) were ineffective in meeting the standards for surface water discharge. Compliance was attained only 5 to 12 times out of 30.

Table 6-3. Treatment Unit Performance Ranking Based on the Frequency of Effluent Compliance with the Surface Water Discharge Limits and the Average Percent Removal.

Unit	Process	Surface Water Limit Compliance	Average Percent Removal	Concerns
CFS	Conventional Run – Floc/Sed (and all subsequent Processes)	30 of 30	0.94	Possible low pH
PA	Proprietary Run - Actiflo® (and all subsequent processes)	30 of 30	0.92	Possible low pH
30-S	Chitosan Sedimentation, 1 mg/L dose, 24 hour Sed time	15 of 15[1]	0.90	Insufficient data
34-F	Fine Sand Filter, Slow Loading, Free Drain (PASS-C®, 2 hour. Sed Time)	30 of 30	0.88	Possible low pH
40-F	Activated Alumina Filter, Slow Load, Submerged (No Chem, 24 hour. Sed Time)	28 of 30	0.94	Elevated pH and Al-D
37-F	Expanded Shale Filter, Slow Loading, Submerged (No Chem, 24 hour. Sed Time)	28 of 30	0.87	Elevated Al-D and greatly elevated pH
38-F	Limestone Filter, Slow Loading, Submerged (No Chem, 24 hour. Sed Time)	23 of 30	0.79	Elevated pH
34-S	PASS-C® Sedimentation, variable dose, 2 hour. Sed Time (Preceding #34-F, Fine Sand Filtration)	20 of 30	0.84	Possible low pH
31-F	Fine Sand Filter, Slow Loading, Free Drain (No Chem, 24 hour. Sed Time)	12 of 30	0.61	
33-F	Fine Sand Filter, Slow Loading, Submerged (No Chem, 2 hour. Sed Time)	11 of 30	0.58	
32-F	Fine Sand Filter, Slow Loading, Free Drain (No Chem, 2 hour. Sed Time)	10 of 30	0.56	
36-F	Fine Sand Filter, Slow Loading, Submerged (No Chem, 24 hour. Sed Time)	10 of 30	0.55	
39-S	Wollastonite Filter, Slow Load, Submerged (No Chem, 24 hour. Sed Time)	3 of 10[2]	0.69	Insufficient data, elevated pH
35-F	Fine Sand Filter, Fast Loading, Free Drain (No Chem, 2 hour. Sed Time)	9 of 30	0.33	
36-S & 38-S	No Chem, 24 hour. Sed Time (Preceding #36-F, Fine Sand Filtration)	7 of 30	0.34	
33-S	No Chem, 2 hour. Sed Time (Preceding #33-F, Fine Sand Filtration)	6 of 30	0.24	
35-S	No Chem, 2 hour. Sed Time (Preceding #35-F, Fine Sand Filtration)	5 of 30	0.13	

[1] Score normalized to 30 of 30 [2] Score normalized to 9 of 30

6.3 Potential Future Testing Activities

The effectiveness of mechanized systems in a batch configuration has been demonstrated in both phases of this project. No further small-scale testing of these systems is suggested. Further testing should be done at a larger scale and with continuous flow, rather than batch treatment.

For the non-mechanized systems, it would be beneficial to conduct further testing to confirm and evaluate the performances of the various adsorptive filter media, to evaluate additional media, and to test the performance of sedimentation systems with alternative chemical coagulants and mixing regimes. Specifically, the following are suggested:

1. Additional testing of media filtration following sedimentation (without chemicals) on the same scale as in Phase II using wollastonite, expanded shale, limestone, and activated alumina media. The purpose of this testing is to confirm the findings of the Phase II program, which are based on six runs at the most and as few as two at the least.

2. Evaluation of the long-term hydraulic and treatment performance of selected media. The water filtered in the six runs during Phase II represents less than 10 percent of what one of these filters would treat during one year in a typical field application. Extended filter runs should be accomplished to evaluate head loss buildup and contaminant breakthrough as a function of volume of water treated. These tests should be done using small (6-inch) filter columns because the larger columns used in Phase II would require excessive volumes of storm water. One 30-inch column should be operated in parallel with a six-inch column to verify that the small columns produce results comparable to the larger ones.

3. Because of the potential exhibited by chemically-enhanced sedimentation, it would be useful to pursue further testing with alternative coagulants and different chemical mixing regimes.

4. Further testing of methods to achieve reliable "passive dosing" of coagulants like chitosan is warranted. Chitosan in liquid form was shown to be an effective coagulant in this application.

References

References

Brooke, L. T. and C. E. Stephan. 1988. Ambient Water Quality Criteria for Aluminum – 1988. EPA 440/5/-86-008. U.S. Environmental Protection Agency Office of Research and Development Environmental Research Lab. U.S. Environmental Protection Agency Office of Water Regulations and Standards, Washington D.C.

Caltrans (California Department of Transportation). 2003. Lake Tahoe Storm Water Treatment Pilot Project Jar Test Results and Summary Report. CTSW-RT-02-075. June, 2003. California Department of Transportation, Sacramento CA.

Caltrans (California Department of Transportation). 2003a. Lake Tahoe Small Scale Storm Water Treatment Pilot Project Phase II Monitoring and Operations Plan. CTSW-RT-01-054. March 2003. California Department of Transportation, Sacramento CA.

Caltrans (California Department of Transportation). 2003b. Lake Tahoe Small Scale Storm Water Treatment Pilot Project First Year Report. CTSW-RT-03-042. August 2003. California Department of Transportation, Sacramento CA.

Caltrans (California Department of Transportation). 2002. BMP Retrofit Pilot Program Proposed Final Report. CTSW-RT-01-050. April 2002. California Department of Transportation, Sacramento CA.

Caltrans (California Department of Transportation). 2002a. Caltrans Tahoe Highway Runoff Characterization and Sand Trap Effectiveness Studies, 2001-02 Monitoring Season. CTSW-RT-02-044. August 2002. California Department of Transportation, Sacramento CA.

Caltrans (California Department of Transportation). 2001a. New Technologies for Storm Water Treatment: Chemical Treatment to Improve Settling (CTIS) Reconnaissance Study. CTSW-RT-01-026 June 2001. California Department of Transportation, Sacramento CA.

Caltrans (California Department of Transportation). 2001b. Alternative Media Literature Review. CTSW-RT-01-039. August 17, 2001. California Department of Transportation, Sacramento CA.

Caltrans (California Department of Transportation). 2001c. Draft Lake Tahoe Storm Water Treatment Pilot Project Monitoring and Operations Plan. CTSW-RT-01-054D. October 10, 2001. California Department of Transportation, Sacramento CA.

Caltrans (California Department of Transportation). 2001d. Experimental Design: Pilot Study Jar Tests for Lake Tahoe Storm Water Treatment. September 13, 2001. California Department of Transportation, Sacramento CA.

Caltrans (California Department of Transportation). 2000. Caltrans Guidance Manual Stormwater Monitoring Protocols, Second Edition. CTSW-RT-00-005. July 2000. California Department of Transportation, Sacramento CA.

Caltrans (California Department of Transportation). 1999. Load Assessment. CTSW-RT-99-078. November, 1999. California Department of Transportation, Sacramento CA.

Federal Highway Administration (FHA), United States Department of Transportation (U.S. DOT) and the United States Geological Survey (USGS). 2000. A Synopsis of Technical Issues of Concern for Monitoring Trace Elements in Highway and Urban Runoff (Open-File Report 00-422). Federal Highway Administration, Northborough, MA.

LRWQCB (Lahontan Regional Water Quality Control Board). 1994. Water Quality Control Plan for the Lahontan Region – North and South Basins. Lahontan Regional Water Quality Control Board, South Lake Tahoe, CA. Accessed September 2001 at http://www.swrcb.ca.gov/rwqcb6/Files/Bplan.pdf.

United States Environmental Protection Agency and the State of California. 2000. Water Quality Standards; Establishment of Numeric Criteria for Priority Toxic Pollutants for the State of California; Rule, (May 18, 2000) Federal Register 40CFR Part 131, Vol. 65, No. 97.

Appendix A

Phase II Project Data

Appendix A Project Data

Caltrans Tahoe Small-Scale Storm Water Pilot - Samples Collected and Log Number Key, Phase II

Abv	Sample Point	Run 7	Run 8	Run 9	Run 10	Run 11	Run 12
I-1	Composite, Day 1	07-I-01	08-I-01	09-I-01	10-I-01	11-I-01	12-I-01
I-2	Composite, Day 1 Replicate (See QA Samples, 41-S)	07-I-02	08-I-02	09-I-02	10-I-02	11-I-02	12-I-02
I-3	Composite, Day 2	07-I-03	08-I-03	09-I-03	10-I-03	11-I-03	12-I-03
JA-1	Jar Test Run, Fixed PASS C (100 mg/L)	07-JA-01	08-JA-01	09-JA-01	10-JA-01	11-JA-01	12-JA-01
JA-2	Jar Test Run, Variable PASS C	07-JA-02	08-JA-02	09-JA-02	10-JA-02	-	12-JA-02
30-S	Chitosan Passively Dosed, 24 hr. Sed. time (Sed only, 6 hr. slow drain)	07-30-S	08-30-S	09-30-S	10-30-S	11-30-S	12-30-S
31-S	No Chem, 24 hr. Sed Time (Preceding #31-F, Fine Sand Filtration)	-	-	-	-	-	-
31-F	Fine Sand Filter, Slow Loading, Free Drain (No Chem, 24 hr. Sed Time)	07-31-F	08-31-F	09-31-F	10-31-F	11-31-F	12-31-F
32-S	No Chem, 2 hr. Sed Time (Preceding #32-F, Fine Sand Filtration)	-	-	-	-	-	-
32-F	Fine Sand Filter, Slow Loading, Free Drain (No Chem, 2 hr. Sed Time)	07-32-F	08-32-F	09-32-F	10-32-F	11-32-F	12-32-F
33-S	No Chem, 2 hr. Sed Time (Preceding #33-F, Fine Sand Filtration)	07-33-S	08-33-S	09-33-S	10-33-S	11-33-S	12-33-S
33-F	Fine Sand Filter, Slow Loading, Submerged (No Chem, 2 hr. Sed Time)	07-33-F	08-33-F	09-33-F	10-33-F	11-33-F	12-33-F
34-S	Variable PASS C, 2 hr. Sed Time (Preceding #34-F, Fine Sand Filtration)	07-34-S	08-34-S	09-34-S	10-34-S	11-34-S	12-34-S
34-F	Fine Sand Filter, Slow Loading, Free Drain (Pass C, 2 hr. Sed Time)	07-34-F	08-34-F	09-34-F	10-34-F	11-34-F	12-34-F
35-S	No Chem, 2 hr. Sed Time (Preceding #35-F, Fine Sand Filtration)	07-35-S	08-35-S	09-35-S	10-35-S	11-35-S	12-35-S
35-F	Fine Sand Filter, Fast Loading, Free Drain (No Chem, 2 hr. Sed Time)	07-35-F	08-35-F	09-35-F	10-35-F	11-35-F	12-35-F
36-S	No Chem, 24 hr. Sed Time (Preceding #36-F, Fine Sand Filtration)	07-36-S	08-36-S	09-36-S	10-36-S	11-36-S	12-36-S
36-F	Fine Sand Filter, Slow Loading, Submerged (No Chem, 24 hr. Sed Time)*	07-36-F	08-36-F	09-36-F	10-36-F	11-36-F	12-36-F
37-S	No Chem, 24 hr. Sed Time (Preceding #37-F, Shale Filtration)	-	-	-	-	-	-
37-F	Shale Filter, Slow Loading, Submerged (No Chem, 24 hr. Sed Time)	07-37-F	08-37-F	09-37-F	10-37-F	11-37-F	12-37-F
38-S	No Chem, 24 hr. Sed Time (Preceding #38-F, Limestone Filtration)	07-38-S	08-38-S	09-38-S	10-38-S	11-38-S	12-38-S
38-F	Limestone Filter, Slow Loading, Submerged (No Chem, 24 hr. Sed Time)	07-38-F	08-38-F	09-38-F	10-38-F	11-38-F	12-38-F
39-S	No Chem, 24 hr. Sed Time (Preceding #39-F, Wollastonite Filtration)	-	-	-	-	-	-
39-F	Wollastone Filter, Slow Loading, Submerged (No Chem, 24 hr. Sed Time)	07-39-F	08-39-F	09-39-F	10-39-F	11-39-F	12-39-F
40-S	No Chem, 24 hr. Sed Time (Preceding #40-F, Activated Al Filtration)	-	-	-	-	-	-
40-F	Activated Al Filter, Slow Load, Submerged (No Chem, 24 hr. Sed Time)	07-40-F	08-40-F	09-40-F	10-40-F	11-40-F	12-40-F
PA	Proprietary Run - Actiflo	07-PA	08-PA	09-PA	10-PA	11-PA	12-PA
PFF	Proprietary Run - Fuzzy Filter	07-PFF	08-PFF	09-PFF	10-PFF	11-PFF	12-PFF
PC	Proprietary Run - Cation Exchange	-	-	-	-	-	-
PCA	Proprietary Run - Anion (after Cation) Exchange	07-PCA	08-PCA	09-PCA	10-PCA	11-PCA	12-PCA
CFS	Conventional Run – Floc/Sed	07-CFS	08-CFS	09-CFS	10-CFS	11-CFS	12-CFS
CPSF	Conventional Run – Pressure Sand Filter	07-CPSF	08-CPSF	09-CPSF	10-CPSF	11-CPSF	12-CPSF
CC	Conventional Run – Cation Exchange	-	-	-	-	-	-
CCA	Conventional Run – Anion (after Cation) Exchange	07-CCA	08-CCA	09-CCA	10-CCA	11-CCA	12-CCA
41-S	Run Duplicate #1	07-41-S (dup of 07-I-01)	08-41-S (dup of 08-I-01)	09-41-S (dup of 09-I-01)	10-41-S (dup of 10-I-01)	11-41-S (dup of 11-I-01)	12-41-S (dup of 12-I-01)
41-F	Run Duplicate #2	07-41-F (dup of 07-PFF)	08-41-F (dup of 08-35-F)	09-41-F (dup of 09-PFF)	10-41-F (dup of 10-PA)	11-41-F (dup of 11-PFF)	12-41-F (dup of 12-PA)
42-S	Run Duplicate #3	07-42-S (dup of 07-30-S)	08-42-S (dup of 08-PCA)	09-42-S (dup of 09-30-S)	10-42-S (dup of 10-38-S)	11-42-S (dup of 11-30-S)	12-42-S (dup of 12-38-S)
42-F	(log number not used)	-	-	-	-	-	-
43-S	Bottle Blank (HPLC directly into bottles)	07-43-S	08-43-S	09-43-S	10-43-S	11-43-S	12-43-S
43-F	Sample Processing Blank #1	07-43-F	08-43-F	09-43-F	10-43-F	11-43-F	12-43-F
44-S	Sample Processing Blank #2	07-44-S	08-44-S	09-44-S	10-44-S	11-44-S	12-44-S
44-F	Equipment Blank (collection barrel, regular sample processing)	07-44-F	08-44-F	09-44-F	10-44-F	11-44-F	12-44-F
PE Samples	PE Sample	07-20-F	-	09-45-F	-	-	-
PE Blanks	PE Sample blank	07-20-S	-	09-45-S	-	-	-
other	Influent sample 3 days prior to use	-	08-001	-	-	-	-

Caltrans Tahoe Small-Scale Storm Water Pilot

Phase II Abbreviations, Notes and Data Qualifiers

Abbreviations	
NVR	No Value Recorded
LOSS	Sample Lost in Shipment
N/A	Not Applicable to this Point
min	Minutes
mg/L	Milligrams per Liter
µg/L	Micrograms per Liter
NTU	Nephelometric Turbidity Units
µmhos/cm	Micromhos per centimeter
mg-$CaCO_3$/L	Milligrams calcium carbonate/Liter
^oC	Degrees Celsius
T, -T or (T)	Total
D, -D, Diss, or (D)	Dissolved (filtered, 0.45 um)

Data Qualifier Definitions	
U	The analyte was analyzed for, but was not detected above the reported sample quantitation limit.
J	The analyte was positively identified; the associated numerical value is the approximate concentration of the analyte in the sample.
UJ	The analyte was not detected above the reported sample quantitation limit. However, the reported quantitation limit is approximate and may or may not represent the actual limit of quantitation necessary to accurately and precisely measure the analyte in the sample.
R	The sample results are rejected due to serious deficiencies in the ability to analyze the sample and meet quality control criteria. The presence or absence of the analyte cannot be verified.
Notes	
AA	Total phosphorus reporting limit for 11-31-F is <0.3 mg/L (not <0.03) due to lab dilution requirements
BB	Outlier nitrate value (3.5 mg/L for 11-38-S) reported by laboratory, with no change in value upon request for re-check. This high value also affects total nitrogen.
CC	Oil and grease reported with a detection limit of <0.5 for this sample (12-CPSF) due to the loss (breakage) of one of the two sample containers
DD	Outlier nitrate value (11-38-S) not used in the calculation of average (24hr Sed Avg)

Data Qualifier Reason Code Definitions	
a	Analytical sequence deficiency or omission.
c	Calibration failure; poor or unstable response.
d	Laboratory duplicate imprecision.
e	Laboratory duplicate control sample imprecision.
f	Field duplicate imprecision.
h	Holding time violation.
l	Laboratory control sample recovery failure.
m	Matrix spike/matrix spike duplicate recovery failure.
o	Calibration blank contamination (metals/inorganics only).
p	Preparation blank contamination (metals/inorganics only).
x	Field or equipment blank contamination.
y	Trip blank contamination.
z	Method blank contamination.
D	Value exceeds quantitation limit.
Q	Dissolved concentration significantly exceeded the total concentration.

Caltrans Lake Tahoe Small-Scale Storm Water Treatment Pilot Plant

Phase II Water Quality Data, 2003

Treatment Designation	PARAMETER	ABV.	UNITS	Run 7 Qualifier	Reason	=	Result	Run 8 Qualifier	Reason	=	Result	Run 9 Qualifier	Reason	=	Result	Run 10 Qualifier	Reason	=	Result	Run 11 Qualifier	Reason	=	Result	Run 12 Qualifier	Reason	=	Result
I-1	Run #	Run #	-				7				8				9				10				11				12
I-1	Date of Collection	Date - Col	-				3/15/2003				3/15/2003				5/6/2003				5/6/2003				5/20/2003				5/27/2003
I-1	Date Run (Day 1)	Date - Run					3/16/2003				3/18/2003				5/6/2003				5/8/2003				5/20/2003				5/27/2003
I-1	Lab Name	Lab	-				Soil/Tox				Soil/Tox				Soil/Tox				Soil/Tox				Soil/Tox				Soil/Tox
I-1	Water Source	Source	-				HY89+Boxes				Ski Run				HY89+Boxes				Ski Run				On-site				Snow Yard
I-1	QC Type	QC-T	-				N/A				N/A				N/A				N/A				N/A				N/A
I-1	QC Reference (dup of sample)	QC-R	-				N/A				N/A				N/A				N/A				N/A				N/A
I-1	Unit (Sed., Filter, Mechanized, etc.)	Unit					Influent				Influent				Influent				Influent				Influent				Influent
I-1	Chemical	Chem.	-				None				None				None				None				None				None
I-1	Chemical Dose	Chem. Dose	mg/L				None				None				None				None				None				None
I-1	Sedimentation Time	Sed. Time	hours				N/A				N/A				N/A				N/A				N/A				N/A
I-1	Filter Media	Media	-				N/A				N/A				N/A				N/A				N/A				N/A
I-1	Filter Loading (6 hour or "fast")	Loading	-				N/A				N/A				N/A				N/A				N/A				N/A
I-1	Filter Outlet (free or submerged)	Filt. Outlet	-				N/A				N/A				N/A				N/A				N/A				N/A
I-1	Pilot Plant ID #	Plant ID#	-				07-I-01				08-I-01				09-I-01				10-I-01				11-I-01				12-I-01
I-1	Laboratory Log #	Lab #	-				T303046-03				T303052-03				T-305008-03				T-305011-28				T-305028-14				T-305040-07
I-1	Alkalinity - total	Alk-T	mg-$CaCO_3$/L				31				28	U	x		37				61				24				30
I-1	Aluminum - acid soluble	Al-AS	µg/L				456				300				130			<	25				480				640
I-1	Aluminum - dissolved	Al-D	µg/L				26			<	25			<	25			<	25			<	25			<	25
I-1	Aluminum - total	Al-T	µg/L				13000				6800				810				320				17000	J	m		23000
I-1	Ammonia	NH_4	mg-N/L				0.1			<	0.1				0.15			<	0.1			<	0.1			<	0.1
I-1	Conductivity (field)	EC	µmhos/cm				593				233				323				278				1413				258
I-1	Iron - dissolved	Fe-D	µg/L				48			<	25				130				40			<	25			<	25
I-1	Iron - total	Fe-T	µg/L				11000				6500				2800				770				21000				20000
I-1	Kjeldahl Nitrogen - dissolved	TKN-D	mg-N/L	UJ	f,x		0.57				0.44	UJ	f,x		0.47	UJ	f,x		0.32			<	0.1	UJ	d,x		0.19
I-1	Kjeldahl Nitrogen - total	TKN-T	mg-N/L				1.4				0.97	J	d		0.70	U	x		0.25				0.93				0.98
I-1	Nitrate Nitrogen	NO_3	mg-N/L			<	0.1			<	0.1			<	0.1	UJ	h	<	0.1			<	0.1			<	0.1
I-1	Nitrite Nitrogen	NO_2	mg-N/L			<	0.1			<	0.1			<	0.1	UJ	h	<	0.1			<	0.1			<	0.1
I-1	Oil & Grease	O&G	mg/L				11				6			<	2	UJ	h	<	2				13			<	2
I-1	Organic Carbon - total	TOC	mg/L				12				9				12				5.3	J	f		16				22
I-1	Orthophosphate - dissolved	OP-D	mg-P/L			<	0.03			<	0.03			<	0.03	UJ	h	<	0.03				0.05			<	0.03
I-1	Orthophosphate - total	OP-T	mg-P/L				0.46				0.21	U	x		0.08	UJ	h	<	0.03				0.64				0.22
I-1	pH (field)	pH	pH Units				8.1				6.9				6.9				7.9				7.4				7.3
I-1	Phosphorus - dissolved	Phos-D	mg-P/L			<	0.03				0.07			<	0.03			<	0.03				0.06			<	0.03
I-1	Phosphorus - total	Phos-T	mg-P/L				0.57				0.52				0.18				0.10				0.87				0.82
I-1	Temperature (field)	Temp	°C				2.9				6.6				9.9				8.1				11.1				15.0
I-1	Total Dissolved Solids	TDS	mg/L				304				144				154				168	U	x		784				264
I-1	Total Nitrogen (calculated)	TN	mg-N/L				1.4				0.97				0.70				0.25				0.93				0.98
I-1	Total Suspended Solids	TSS	mg/L				364				184				68				24				440				220
I-1	Turbidity (field)	Turb	NTU				445				204				60.4				15.0				554				573

Caltrans Lake Tahoe Small-Scale Storm Water Treatment Pilot Plant

Phase II Water Quality Data, 2003

Treatment Designation	PARAMETER	ABV.	UNITS	Run 7				Run 8				Run 9				Run 10				Run 11				Run 12			
				Data Qualifier	Reason	=	Result	Data Qualifier	Reason	=	Result	Data Qualifier	Reason	=	Result	Data Qualifier	Reason	=	Result	Data Qualifier	Reason	=	Result	Data Qualifier	Reason	=	Result
I-2	Run #	Run #	-				7				8				9				10				11				12
I-2	Date of Collection	Date - Col	-				3/15/2003				3/15/2003				5/6/2003				5/6/2003				5/20/2003				5/27/2003
I-2	Date Run (Day 1)	Date - Run					3/16/2003				3/18/2003				5/6/2003				5/8/2003				5/20/2003				5/27/2003
I-2	Lab Name	Lab	-				Soil/Tox				Soil/Tox				Soil/Tox				Soil/Tox				Soil/Tox				Soil/Tox
I-2	Water Source	Source	-				HY89+Boxes				Ski Run				HY89+Boxes				Ski Run				On-site				Snow Yard
I-2	QC Type	QC-T	-				Duplicate				Duplicate				Duplicate				Duplicate				Duplicate				Duplicate
I-2	QC Reference (dup of sample)	QC-R	-				See 41-S				See 41-S				See 41-S				See 41-S				See 41-S				See 41-S
I-2	Unit (Sed., Filter, Mechanized, etc.)	Unit					Influent				Influent				Influent				Influent				Influent				Influent
I-2	Chemical	Chem.	-				None				None				None				None				None				None
I-2	Chemical Dose	Chem. Dose	mg/L				None				None				None				None				None				None
I-2	Sedimentation Time	Sed. Time	hours				N/A				N/A				N/A				N/A				N/A				N/A
I-2	Filter Media	Media	-				N/A				N/A				N/A				N/A				N/A				N/A
I-2	Filter Loading (6 hour or "fast")	Loading	-				N/A				N/A				N/A				N/A				N/A				N/A
I-2	Filter Outlet (free or submerged)	Filt. Outlet	-				N/A				N/A				N/A				N/A				N/A				N/A
I-2	Pilot Plant ID #	Plant ID#	-				07-41-S				08-41-S				09-41-S				10-41-S				11-41-S				12-41-S
I-2	Laboratory Log #	Lab #	-				T303046-02				T303052-07				T-305008-06				T-305011-23				T-305028-07				T-305040-08
I-2	Alkalinity - total	Alk-T	mg-$CaCO_3$/L				29				28	U	x		37				63				24				30
I-2	Aluminum - acid soluble	Al-AS	µg/L				500				260				140				33				920				600
I-2	Aluminum - dissolved	Al-D	µg/L				27	U	x		34			<	25			<	25			<	25			<	25
I-2	Aluminum - total	Al-T	µg/L				11000				6900				2300				390				21000	J	m		18000
I-2	Ammonia	NH_4	mg-N/L			<	0.1			<	0.1				0.15			<	0.1			<	0.1			<	0.1
I-2	Conductivity (field)	EC	µmhos/cm				612				242				303				276				1433				256
I-2	Iron - dissolved	Fe-D	µg/L				48				36				120				40			<	25			<	25
I-2	Iron - total	Fe-T	µg/L				10000				6300				2900				800				20000				20000
I-2	Kjeldahl Nitrogen - dissolved	TKN-D	mg-N/L	UJ	f,x		0.22				0.58	J	f,Q		1.3	UJ	f,x		0.19	U	x		0.15	UJ	d	<	0.1
I-2	Kjeldahl Nitrogen - total	TKN-T	mg-N/L				1.4				0.97	J	d,Q		0.70	U	x		0.26	J	d		0.94				0.95
I-2	Nitrate Nitrogen	NO_3	mg-N/L			<	0.1			<	0.1	UJ	h	<	0.1	UJ	h	<	0.1			<	0.1			<	0.1
I-2	Nitrite Nitrogen	NO_2	mg-N/L			<	0.1			<	0.1	UJ	h	<	0.1	UJ	h	<	0.1			<	0.1			<	0.1
I-2	Oil & Grease	O&G	mg/L				10				5			<	2	UJ	h	<	2				8			<	2
I-2	Organic Carbon - total	TOC	mg/L				11				15				5.2	J	f		10				14				
I-2	Orthophosphate - dissolved	OP-D	mg-P/L			<	0.03			<	0.03	UJ	h	<	0.03	UJ	h	<	0.03				0.04			<	0.03
I-2	Orthophosphate - total	OP-T	mg-P/L				0.43				0.21	UJ	h,x		0.06	UJ	h	<	0.03				0.70				0.25
I-2	pH (field)	pH	pH Units				8.0				6.7				6.9				7.9				7.4				7.3
I-2	Phosphorus - dissolved	Phos-D	mg-P/L			<	0.03				0.04			<	0.03				0.09				0.06			<	0.03
I-2	Phosphorus - total	Phos-T	mg-P/L				0.54				0.47				0.17				0.10				0.68				0.88
I-2	Temperature (field)	Temp	°C				3.0				6.6				9.4				8.1				11.2				15.6
I-2	Total Dissolved Solids	TDS	mg/L				320				152				162				180	U	x		784				276
I-2	Total Nitrogen (calculated)	TN	mg-N/L				1.4				0.97				0.70				0.26				0.94				0.95
I-2	Total Suspended Solids	TSS	mg/L				364				172				58				22				492				252
I-2	Turbidity (field)	Turb	NTU				416				194				61.1				15.5				566				581

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Phase II Water Quality Data, 2003

Treatment Designation	PARAMETER	ABV.	UNITS	Run 7				Run 8				Run 9				Run 10				Run 11				Run 12			
				Data Qualifier	Reason	=	Result	Data Qualifier	Reason	=	Result	Data Qualifier	Reason	=	Result	Data Qualifier	Reason	=	Result	Data Qualifier	Reason	=	Result	Data Qualifier	Reason	=	Result
I-3	Run #	Run #	-				7				8				9				10				11				12
I-3	Date of Collection	Date - Col	-				3/15/2003				3/15/2003				5/6/2003				5/6/2003				5/20/2003				5/27/2003
I-3	Date Run (Day 1)	Date - Run					3/16/2003				3/18/2003				5/6/2003				5/8/2003				5/20/2003				5/27/2003
I-3	Lab Name	Lab	-				Soil/Tox				Soil/Tox				Soil/Tox				Soil/Tox				Soil/Tox				Soil/Tox
I-3	Water Source	Source	-				HY89+Boxes				Ski Run				HY89+Boxes				Ski Run				On-site				Snow Yard
I-3	QC Type	QC-T	-				N/A				N/A				N/A				N/A				N/A				N/A
I-3	QC Reference (dup of sample)	QC-R	-				N/A				N/A				N/A				N/A				N/A				N/A
I-3	Unit (Sed., Filter, Mechanized, etc.)	Unit					Influent				Influent				Influent				Influent				Influent				Influent
I-3	Chemical	Chem.	-				None				None				None				None				None				None
I-3	Chemical Dose	Chem. Dose	mg/L				None				None				None				None				None				None
I-3	Sedimentation Time	Sed. Time	hours				N/A				N/A				N/A				N/A				N/A				N/A
I-3	Filter Media	Media	-				N/A				N/A				N/A				N/A				N/A				N/A
I-3	Filter Loading (6 hour or "fast")	Loading	-				N/A				N/A				N/A				N/A				N/A				N/A
I-3	Filter Outlet (free or submerged)	Filt. Outlet	-				N/A				N/A				N/A				N/A				N/A				N/A
I-3	Pilot Plant ID #	Plant ID#	-				07-I-03				08-I-03				09-I-03				10-I-03				11-I-03				12-I-03
I-3	Laboratory Log #	Lab #	-				T303046-21				T303052-04				T-305008-32				T-305011-29				T-305028-15				T-305040-21
I-3	Alkalinity - total	Alk-T	mg-$CaCO_3$/L				30				28	U	x		37				61				24				30
I-3	Aluminum - acid soluble	Al-AS	µg/L				422				320				150			<	25				730				400
I-3	Aluminum - dissolved	Al-D	µg/L				29			<	25			<	25			<	25			<	25			<	25
I-3	Aluminum - total	Al-T	µg/L				12000				6200				640				320				17000	J	m		21000
I-3	Ammonia	NH_4	mg-N/L			<	0.1			<	0.1				0.11			<	0.1			<	0.1			<	0.1
I-3	Conductivity (field)	EC	µmhos/cm				593				253				283				277				1404				264
I-3	Iron - dissolved	Fe-D	µg/L				40			<	25				100				38			<	25			<	25
I-3	Iron - total	Fe-T	µg/L				11000				6500				2600				660				21000				21000
I-3	Kjeldahl Nitrogen - dissolved	TKN-D	mg-N/L	U	x		0.35				0.70	UJ	d,x		0.64	U	x		0.32			<	0.1	U	x		0.26
I-3	Kjeldahl Nitrogen - total	TKN-T	mg-N/L				1.4				1.0				0.75	U	x		0.26				1.0				0.99
I-3	Nitrate Nitrogen	NO_3	mg-N/L			<	0.1			<	0.1	UJ	h	<	0.1	J	h		0.11			<	0.1			<	0.1
I-3	Nitrite Nitrogen	NO_2	mg-N/L			<	0.1			<	0.1	UJ	h	<	0.1	UJ	h	<	0.1			<	0.1			<	0.1
I-3	Oil & Grease	O&G	mg/L				11				5			<	2	UJ	h	<	2				13			<	2
I-3	Organic Carbon - total	TOC	mg/L	J	m		14				9				12				5.5				20				12
I-3	Orthophosphate - dissolved	OP-D	mg-P/L			<	0.03			<	0.03	UJ	h	<	0.03	UJ	h	<	0.03				0.04			<	0.03
I-3	Orthophosphate - total	OP-T	mg-P/L				0.35				0.21	UJ	h	<	0.03	UJ	h	<	0.03				0.68				0.25
I-3	pH (field)	pH	pH Units				7.4				6.9				7.1				7.9				7.5				7.3
I-3	Phosphorus - dissolved	Phos-D	mg-P/L			<	0.03				0.05				0.03				0.05				0.06			<	0.03
I-3	Phosphorus - total	Phos-T	mg-P/L				0.75				0.52				0.18				0.07				1.1				0.88
I-3	Temperature (field)	Temp	°C				4.6				6.8				9.3				8.4				10.9				14.0
I-3	Total Dissolved Solids	TDS	mg/L				314				142				162				168	U	x		776				264
I-3	Total Nitrogen (calculated)	TN	mg-N/L				1.4				1.0				0.75				0.37				1.0				0.99
I-3	Total Suspended Solids	TSS	mg/L				380				170				56				22				508				208
I-3	Turbidity (field)	Turb	NTU				332				192				65.1				15.1				548				574

Caltrans Lake Tahoe Small-Scale Storm Water Treatment Pilot Plant

Phase II Water Quality Data, 2003

Treatment Designation	PARAMETER	ABV.	UNITS	Run 7 Data Qualifier	Run 7 Reason	Run 7 Result	Run 8 Data Qualifier	Run 8 Reason	Run 8 Result	Run 9 Data Qualifier	Run 9 Reason	Run 9 Result	Run 10 Data Qualifier	Run 10 Reason	Run 10 Result	Run 11 Data Qualifier	Run 11 Reason	Run 11 Result	Run 12 Data Qualifier	Run 12 Reason	Run 12 Result
I-Avg	Run #	Run #	-		=	7		=	8		=	9		=	10		=	11		=	12
I-Avg	Date of Collection	Date - Col	-		=	3/15/2003		=	3/15/2003		=	5/6/2003		=	5/6/2003		=	5/20/2003		=	5/27/2003
I-Avg	Date Run (Day 1)	Date - Run			=	3/16/2003		=	3/18/2003		=	5/6/2003		=	5/8/2003		=	5/20/2003		=	5/27/2003
I-Avg	Lab Name	Lab	-		=	Soil/Tox		=	Soil/Tox		=	Soil/Tox		=	Soil/Tox		=	Soil/Tox		=	Soil/Tox
I-Avg	Water Source	Source	-		=	HY89+Boxes		=	Ski Run		=	HY89+Boxes		=	Ski Run		=	On-site		=	Snow Yard
I-Avg	QC Type	QC-T	-		=	Calc. Value		=	Calc. Value		=	Calc. Value		=	Calc. Value		=	Calc. Value		=	Calc. Value
I-Avg	QC Reference (dup of sample)	QC-R	-		=	N/A		=	N/A		=	N/A		=	N/A		=	N/A		=	N/A
I-Avg	Unit (Sed., Filter, Mechanized, etc.)	Unit			=	Influent		=	Influent		=	Influent		=	Influent		=	Influent		=	Influent
I-Avg	Chemical	Chem.	-		=	None		=	None		=	None		=	None		=	None		=	None
I-Avg	Chemical Dose	Chem. Dose	mg/L		=	None		=	None		=	None		=	None		=	None		=	None
I-Avg	Sedimentation Time	Sed. Time	hours		=	N/A		=	N/A		=	N/A		=	N/A		=	N/A		=	N/A
I-Avg	Filter Media	Media	-		=	N/A		=	N/A		=	N/A		=	N/A		=	N/A		=	N/A
I-Avg	Filter Loading (6 hour or "fast")	Loading	-		=	N/A		=	N/A		=	N/A		=	N/A		=	N/A		=	N/A
I-Avg	Filter Outlet (free or submerged)	Filt. Outlet	-		=	N/A		=	N/A		=	N/A		=	N/A		=	N/A		=	N/A
I-Avg	Pilot Plant ID #	Plant ID#	-		=	07-I-Avg		=	08-I-Avg		=	09-I-Avg		=	10-I-Avg		=	11-I-Avg		=	12-I-Avg
I-Avg	Laboratory Log #	Lab #	-		=	N/A		=	N/A		=	N/A		=	N/A		=	N/A		=	N/A
I-Avg	Alkalinity - total	Alk-T	mg-$CaCO_3$/L		=	30		=	28		=	37		=	62		=	24		=	30
I-Avg	Aluminum - acid soluble	Al-AS	µg/L		=	459		=	293		=	140		<	25		=	710		=	547
I-Avg	Aluminum - dissolved	Al-D	µg/L		=	27		<	25		<	25		<	25		<	25		<	25
I-Avg	Aluminum - total	Al-T	µg/L		=	12000		=	6633		=	1250		=	343		=	18333		=	20667
I-Avg	Ammonia	NH_4	mg-N/L		<	0.1		<	0.1		=	0.14		<	0.1		<	0.1		<	0.1
I-Avg	Conductivity (field)	EC	µmhos/cm		=	599		=	242		=	303		=	277		=	1417		=	259
I-Avg	Iron - dissolved	Fe-D	µg/L		=	45		<	25		=	117		=	39		<	25		<	25
I-Avg	Iron - total	Fe-T	µg/L		=	10667		=	6433		=	2767		=	743		=	20667		=	20333
I-Avg	Kjeldahl Nitrogen - dissolved	TKN-D	mg-N/L		=	0.38		=	0.57		=	0.8		=	0.28		<	0.1		=	0.17
I-Avg	Kjeldahl Nitrogen - total	TKN-T	mg-N/L		=	1.4		=	0.98		=	0.72		=	0.26		=	0.96		=	0.97
I-Avg	Nitrate Nitrogen	NO_3	mg-N/L		<	0.1		<	0.1		<	0.1		<	0.1		<	0.1		<	0.1
I-Avg	Nitrite Nitrogen	NO_2	mg-N/L		<	0.1		<	0.1		<	0.1		<	0.1		<	0.1		<	0.1
I-Avg	Oil & Grease	O&G	mg/L		=	11		=	5		<	2		<	2		=	11		<	2
I-Avg	Organic Carbon - total	TOC	mg/L		=	12		=	11		=	13		=	5.3		=	15		=	16
I-Avg	Orthophosphate - dissolved	OP-D	mg-P/L		<	0.03		<	0.03		<	0.03		<	0.03		=	0.04		<	0.03
I-Avg	Orthophosphate - total	OP-T	mg-P/L		=	0.41		=	0.21		=	0.05		<	0.03		=	0.67		=	0.24
I-Avg	pH (field)	pH	pH Units		=	7.8		=	6.8		=	7.0		=	7.9		=	7.4		=	7.3
I-Avg	Phosphorus - dissolved	Phos-D	mg-P/L		<	0.03		=	0.05		<	0.03		=	0.05		=	0.06		<	0.03
I-Avg	Phosphorus - total	Phos-T	mg-P/L		=	0.62		=	0.50		=	0.18		=	0.09		=	0.88		=	0.86
I-Avg	Temperature (field)	Temp	°C		=	3.5		=	6.7		=	9.5		=	8.2		=	11.1		=	14.9
I-Avg	Total Dissolved Solids	TDS	mg/L		=	312		=	146		=	159		=	172		=	781		=	268
I-Avg	Total Nitrogen (calculated)	TN	mg-N/L		=	1.4		=	0.98		=	0.72		=	0.29		=	0.96		=	0.97
I-Avg	Total Suspended Solids	TSS	mg/L		=	369		=	175		=	60.1		=	22.7		=	480		=	227
I-Avg	Turbidity (field)	Turb	NTU		=	397		=	197		=	62.2		=	15.2		=	556		=	576

Caltrans Lake Tahoe Small-Scale Storm Water Treatment Pilot Plant

Phase II Water Quality Data, 2003

Treatment Designation	PARAMETER	ABV.	UNITS	Run 7 Data Qualifier	Run 7 Result Reason =	Run 8 Data Qualifier	Run 8 Result Reason =	Run 9 Data Qualifier	Run 9 Result Reason =	Run 10 Data Qualifier	Run 10 Result Reason =	Run 11 Data Qualifier	Run 11 Result Reason =	Run 12 Data Qualifier	Run 12 Result Reason =
JA-1	Run #	Run #	-		7		8		9		10		11		12
JA-1	Date of Collection	Date - Col	-		3/15/2003		3/15/2003		5/6/2003		5/6/2003		5/20/2003		5/27/2003
JA-1	Date Run (Day 1)	Date - Run			3/16/2003		3/18/2003		5/6/2003		5/8/2003		5/20/2003		5/27/2003
JA-1	Lab Name	Lab	-		Soil/Tox		Soil/Tox		Soil/Tox		Soil/Tox		Soil/Tox		Soil/Tox
JA-1	Water Source	Source	-		HY89+Boxes		Ski Run		HY89+Boxes		Ski Run		On-site		Snow Yard
JA-1	QC Type	QC-T	-		N/A		N/A		N/A		N/A		N/A		N/A
JA-1	QC Reference (dup of sample)	QC-R	-		N/A		N/A		N/A		N/A		N/A		N/A
JA-1	Unit (Sed., Filter, Mechanized, etc.)	Unit			Influent		Influent		Influent		Influent		Influent		Influent
JA-1	Chemical	Chem.	-		Pass C		Pass C		Pass C		Pass C		Pass C		Pass C
JA-1	Chemical Dose	Chem. Dose	mg/L		100		100		100		100		100		100
JA-1	Sedimentation Time	Sed. Time	hours		2		2		2		2		2		2
JA-1	Filter Media	Media	-		N/A		N/A		N/A		N/A		N/A		N/A
JA-1	Filter Loading (6 hour or "fast")	Loading	-		N/A		N/A		N/A		N/A		N/A		N/A
JA-1	Filter Outlet (free or submerged)	Filt. Outlet	-		N/A		N/A		N/A		N/A		N/A		N/A
JA-1	Pilot Plant ID #	Plant ID#	-		07-JA-01		08-JA-01		09-JA-01		10-JA-1		11-JA-1		12-JA-01
JA-1	Laboratory Log #	Lab #	-		T-303046-34		T-303052-01		T-305008-33		T-305011-05		T-305028-32		T-305040-32
JA-1	Alkalinity - total	Alk-T	mg-$CaCO_3$/L												
JA-1	Aluminum - acid soluble	Al-AS	µg/L												
JA-1	Aluminum - dissolved	Al-D	µg/L												
JA-1	Aluminum - total	Al-T	µg/L												
JA-1	Ammonia	NH_4	mg-N/L												
JA-1	Conductivity (field)	EC	µmhos/cm		627		260		318		305		1425		290
JA-1	Iron - dissolved	Fe-D	µg/L												
JA-1	Iron - total	Fe-T	µg/L												
JA-1	Kjeldahl Nitrogen - dissolved	TKN-D	mg-N/L												
JA-1	Kjeldahl Nitrogen - total	TKN-T	mg-N/L												
JA-1	Nitrate Nitrogen	NO_3	mg-N/L												
JA-1	Nitrite Nitrogen	NO_2	mg-N/L												
JA-1	Oil & Grease	O&G	mg/L												
JA-1	Organic Carbon - total	TOC	mg/L												
JA-1	Orthophosphate - dissolved	OP-D	mg-P/L												
JA-1	Orthophosphate - total	OP-T	mg-P/L												
JA-1	pH (field)	pH	pH Units		7.5		6.6		6.7		7.0		6.5		6.8
JA-1	Phosphorus - dissolved	Phos-D	mg-P/L		< 0.03		< 0.03		< 0.03		0.04		< 0.03		< 0.03
JA-1	Phosphorus - total	Phos-T	mg-P/L		< 0.03		0.05		0.12		0.06		< 0.03		< 0.03
JA-1	Temperature (field)	Temp	°C		9.4		6.6		10.7		9.5		15.6		19.4
JA-1	Total Dissolved Solids	TDS	mg/L												
JA-1	Total Nitrogen (calculated)	TN	mg-N/L												
JA-1	Total Suspended Solids	TSS	mg/L												
JA-1	Turbidity (field)	Turb	NTU		3.9		6.9		1.0		0.17		2.8		3.2

Caltrans Lake Tahoe Small-Scale Storm Water Treatment Pilot Plant

Phase II Water Quality Data, 2003

Treatment Designation	PARAMETER	ABV.	UNITS	Run 7 Data Qualifier	Run 7 Result Reason =	Run 8 Data Qualifier	Run 8 Result Reason =	Run 9 Data Qualifier	Run 9 Result Reason =	Run 10 Data Qualifier	Run 10 Result Reason =	Run 11 Data Qualifier	Run 11 Result Reason =	Run 12 Data Qualifier	Run 12 Result Reason =
JA-2	Run #	Run #	-		7		8		9		10		11		12
JA-2	Date of Collection	Date - Col	-		3/15/2003		3/15/2003		5/6/2003		5/6/2003		5/20/2003		5/27/2003
JA-2	Date Run (Day 1)	Date - Run			3/16/2003		3/18/2003		5/6/2003		5/8/2003		5/20/2003		5/27/2003
JA-2	Lab Name	Lab	-		Soil/Tox		Soil/Tox		Soil/Tox		Soil/Tox		Soil/Tox		Soil/Tox
JA-2	Water Source	Source	-		HY89+Boxes		Ski Run		HY89+Boxes		Ski Run		On-site		Snow Yard
JA-2	QC Type	QC-T	-		N/A		N/A		N/A		N/A		N/A		N/A
JA-2	QC Reference (dup of sample)	QC-R	-		N/A		N/A		N/A		N/A		N/A		N/A
JA-2	Unit (Sed., Filter, Mechanized, etc.)	Unit			Influent		Influent		Influent		Influent		Influent		Influent
JA-2	Chemical	Chem.	-		Pass C		Pass C		Pass C		Pass C		Pass C		Pass C
JA-2	Chemical Dose	Chem. Dose	mg/L		75		75		170		200		100		120
JA-2	Sedimentation Time	Sed. Time	hours		2		2		2		2		2		2
JA-2	Filter Media	Media	-		N/A		N/A		N/A		N/A		N/A		N/A
JA-2	Filter Loading (6 hour or "fast")	Loading	-		N/A		N/A		N/A		N/A		N/A		N/A
JA-2	Filter Outlet (free or submerged)	Filt. Outlet	-		N/A		N/A		N/A		N/A		N/A		N/A
JA-2	Pilot Plant ID #	Plant ID#	-		07-JA-02		08-JA-02		09-JA-02		10-JA-2		No Sample		12-JA-02
JA-2	Laboratory Log #	Lab #	-		T-303046-35		T-303052-02		T-305008-34		T-305011-06				T-305040-33
JA-2	Alkalinity - total	Alk-T	mg-$CaCO_3$/L												
JA-2	Aluminum - acid soluble	Al-AS	µg/L												
JA-2	Aluminum - dissolved	Al-D	µg/L												
JA-2	Aluminum - total	Al-T	µg/L												
JA-2	Ammonia	NH_4	mg-N/L												
JA-2	Conductivity (field)	EC	µmhos/cm		607		272		325		324				296
JA-2	Iron - dissolved	Fe-D	µg/L												
JA-2	Iron - total	Fe-T	µg/L												
JA-2	Kjeldahl Nitrogen - dissolved	TKN-D	mg-N/L												
JA-2	Kjeldahl Nitrogen - total	TKN-T	mg-N/L												
JA-2	Nitrate Nitrogen	NO_3	mg-N/L												
JA-2	Nitrite Nitrogen	NO_2	mg-N/L												
JA-2	Oil & Grease	O&G	mg/L												
JA-2	Organic Carbon - total	TOC	mg/L												
JA-2	Orthophosphate - dissolved	OP-D	mg-P/L												
JA-2	Orthophosphate - total	OP-T	mg-P/L												
JA-2	pH (field)	pH	pH Units		7.1		6.9		6.4		6.7				6.7
JA-2	Phosphorus - dissolved	Phos-D	mg-P/L		< 0.03		< 0.03		< 0.03		< 0.03				< 0.03
JA-2	Phosphorus - total	Phos-T	mg-P/L		< 0.03		< 0.03		< 0.03		< 0.03				< 0.03
JA-2	Temperature (field)	Temp	°C		9.6		6.4		10.7		9.3				19.5
JA-2	Total Dissolved Solids	TDS	mg/L												
JA-2	Total Nitrogen (calculated)	TN	mg-N/L												
JA-2	Total Suspended Solids	TSS	mg/L												
JA-2	Turbidity (field)	Turb	NTU		1.9		2.9		1.24		0.20				4.9

Caltrans Lake Tahoe Small-Scale Storm Water Treatment Pilot Plant

Phase II Water Quality Data, 2003

Treatment Designation	PARAMETER	ABV.	UNITS	Run 7				Run 8				Run 9				Run 10				Run 11				Run 12			
				Data Qualifier	Reason	=	Result	Data Qualifier	Reason	=	Result	Data Qualifier	Reason	=	Result	Data Qualifier	Reason	=	Result	Data Qualifier	Reason	=	Result	Data Qualifier	Reason	=	Result
30-S	Run #	Run #	-				7				8				9				10				11				12
30-S	Date of Collection	Date - Col	-				3/15/2003				3/15/2003				5/6/2003				5/6/2003				5/20/2003				5/27/2003
30-S	Date Run (Day 1)	Date - Run					3/16/2003				3/18/2003				5/6/2003				5/8/2003				5/20/2003				5/27/2003
30-S	Lab Name	Lab	-				Soil/Tox				Soil/Tox				Soil/Tox				Soil/Tox				Soil/Tox				Soil/Tox
30-S	Water Source	Source	-				HY89+Boxes				Ski Run				HY89+Boxes				Ski Run				On-site				Snow Yard
30-S	QC Type	QC-T	-				N/A				N/A				N/A				N/A				N/A				N/A
30-S	QC Reference (dup of sample)	QC-R	-				N/A				N/A				N/A				N/A				N/A				N/A
30-S	Unit (Sed., Filter, Mechanized, etc.)	Unit					Sed.				Sed.				Sed.				Sed.				Sed.				Sed.
30-S	Chemical	Chem.	-				Chitosan				Chitosan				Chitosan				Chitosan				Chitosan				Chitosan
30-S	Chemical Dose	Chem. Dose	mg/L				Passive				Passive				0.53				1.1				0.98				1.0
30-S	Sedimentation Time	Sed. Time	hours				24				24				24				24				24				24
30-S	Filter Media	Media	-				N/A				N/A				N/A				N/A				N/A				N/A
30-S	Filter Loading (6 hour or "fast")	Loading	-				N/A				N/A				N/A				N/A				N/A				N/A
30-S	Filter Outlet (free or submerged)	Filt. Outlet	-				N/A				N/A				N/A				N/A				N/A				N/A
30-S	Pilot Plant ID #	Plant ID#	-				07-30-S				08-30-S				09-30-S				10-30-S				11-30-S				12-30-S
30-S	Laboratory Log #	Lab #	-				T303046-25				T303052-22				T-305008-17				T-305011-07				T-305028-19				T-305040-22
30-S	Alkalinity - total	Alk-T	mg-$CaCO_3$/L				29				29	U	x		39				63				23				29
30-S	Aluminum - acid soluble	Al-AS	µg/L				317				150			<	25			<	25			<	25			<	25
30-S	Aluminum - dissolved	Al-D	µg/L			<	25			<	25			<	25			<	25			<	25			<	25
30-S	Aluminum - total	Al-T	µg/L				5200				2600				470				56				240	UJ	m		220
30-S	Ammonia	NH_4	mg-N/L			<	0.1			<	0.1				0.14			<	0.1			<	0.1			<	0.1
30-S	Conductivity (field)	EC	µmhos/cm				581				257				284				280				1399				266
30-S	Iron - dissolved	Fe-D	µg/L				37			<	25				36			<	25			<	25			<	25
30-S	Iron - total	Fe-T	µg/L				4800				2800				1400				100	J	m		170				230
30-S	Kjeldahl Nitrogen - dissolved	TKN-D	mg-N/L	U	x		0.18				0.51	U	x		0.37	U	x		0.30	U	x		0.14	U	x		0.27
30-S	Kjeldahl Nitrogen - total	TKN-T	mg-N/L				0.53				0.55	J	d		0.59	U	x		0.22			<	0.1	U	x		0.21
30-S	Nitrate Nitrogen	NO_3	mg-N/L			<	0.1			<	0.1			<	0.1			<	0.1			<	0.1			<	0.1
30-S	Nitrite Nitrogen	NO_2	mg-N/L			<	0.1			<	0.1			<	0.1			<	0.1			<	0.1			<	0.1
30-S	Oil & Grease	O&G	mg/L				4			<	2			<	2			<	2			<	2			<	2
30-S	Organic Carbon - total	TOC	mg/L	J	m		10				8				10				5.4				2				3
30-S	Orthophosphate - dissolved	OP-D	mg-P/L			<	0.03			<	0.03			<	0.03			<	0.03				0.04			<	0.03
30-S	Orthophosphate - total	OP-T	mg-P/L				0.15				0.08			<	0.03			<	0.03				0.04			<	0.03
30-S	pH (field)	pH	pH Units				7.1				7.0				7.1				7.9				7.3				7.2
30-S	Phosphorus - dissolved	Phos-D	mg-P/L			<	0.03				0.08			<	0.03				0.03				0.05			<	0.03
30-S	Phosphorus - total	Phos-T	mg-P/L				0.27				0.20	J	f		0.12			<	0.03				0.07			<	0.03
30-S	Temperature (field)	Temp	°C				2.2				6.2				7.7				7.5				12.9				15.6
30-S	Total Dissolved Solids	TDS	mg/L				312				164				152				216	U	x		710				122
30-S	Total Nitrogen (calculated)	TN	mg-N/L				0.53				0.55				0.59				0.22			<	0.1				0.21
30-S	Total Suspended Solids	TSS	mg/L				108				46				40			<	1	U	x		6			<	1
30-S	Turbidity (field)	Turb	NTU				162				79.8				46.8				2.6				4.3				5.4

Caltrans Lake Tahoe Small-Scale Storm Water Treatment Pilot Plant

Phase II Water Quality Data, 2003

Treatment Designation	PARAMETER	ABV.	UNITS	Run 7		Run 8		Run 9		Run 10		Run 11		Run 12	
				Data Qualifier	Result Reason =	Data Qualifier	Result Reason =	Data Qualifier	Result Reason =	Data Qualifier	Result Reason =	Data Qualifier	Result Reason =	Data Qualifier	Result Reason =
31-S	Run #	Run #	-		7		8		9		10		11		12
31-S	Date of Collection	Date - Col	-		3/15/2003		3/15/2003		5/6/2003		5/6/2003		5/20/2003		5/27/2003
31-S	Date Run (Day 1)	Date - Run			3/16/2003		3/18/2003		5/6/2003		5/8/2003		5/20/2003		5/27/2003
31-S	Lab Name	Lab	-		Soil/Tox		Soil/Tox		Soil/Tox		Soil/Tox		Soil/Tox		Soil/Tox
31-S	Water Source	Source	-		HY89+Boxes		Ski Run		HY89+Boxes		Ski Run		On-site		Snow Yard
31-S	QC Type	QC-T	-		N/A		N/A		N/A		N/A		N/A		N/A
31-S	QC Reference (dup of sample)	QC-R	-		N/A		N/A		N/A		N/A		N/A		N/A
31-S	Unit (Sed., Filter, Mechanized, etc.)	Unit			Sed.		Sed.		Sed.		Sed.		Sed.		Sed.
31-S	Chemical	Chem.	-		None		None		None		None		None		None
31-S	Chemical Dose	Chem. Dose	mg/L		None		None		None		None		None		None
31-S	Sedimentation Time	Sed. Time	hours		24		24		24		24		24		24
31-S	Filter Media	Media	-		N/A		N/A		N/A		N/A		N/A		N/A
31-S	Filter Loading (6 hour or "fast")	Loading	-		N/A		N/A		N/A		N/A		N/A		N/A
31-S	Filter Outlet (free or submerged)	Filt. Outlet	-		N/A		N/A		N/A		N/A		N/A		N/A
31-S	Pilot Plant ID #	Plant ID#	-		Not Sampled		Not Sampled		Not Sampled		Not Sampled		Not Sampled		Not Sampled
31-S	Laboratory Log #	Lab #	-												
31-S	Alkalinity - total	Alk-T	mg-$CaCO_3$/L												
31-S	Aluminum - acid soluble	Al-AS	µg/L												
31-S	Aluminum - dissolved	Al-D	µg/L												
31-S	Aluminum - total	Al-T	µg/L												
31-S	Ammonia	NH_4	mg-N/L												
31-S	Conductivity (field)	EC	µmhos/cm												
31-S	Iron - dissolved	Fe-D	µg/L												
31-S	Iron - total	Fe-T	µg/L												
31-S	Kjeldahl Nitrogen - dissolved	TKN-D	mg-N/L												
31-S	Kjeldahl Nitrogen - total	TKN-T	mg-N/L												
31-S	Nitrate Nitrogen	NO_3	mg-N/L												
31-S	Nitrite Nitrogen	NO_2	mg-N/L												
31-S	Oil & Grease	O&G	mg/L												
31-S	Organic Carbon - total	TOC	mg/L												
31-S	Orthophosphate - dissolved	OP-D	mg-P/L												
31-S	Orthophosphate - total	OP-T	mg-P/L												
31-S	pH (field)	pH	pH Units												
31-S	Phosphorus - dissolved	Phos-D	mg-P/L												
31-S	Phosphorus - total	Phos-T	mg-P/L												
31-S	Temperature (field)	Temp	°C												
31-S	Total Dissolved Solids	TDS	mg/L												
31-S	Total Nitrogen (calculated)	TN	mg-N/L												
31-S	Total Suspended Solids	TSS	mg/L												
31-S	Turbidity (field)	Turb	NTU												

Caltrans Lake Tahoe Small-Scale Storm Water Treatment Pilot Plant

Phase II Water Quality Data, 2003

Treatment Designation	PARAMETER	ABV.	UNITS	Run 7				Run 8				Run 9				Run 10				Run 11				Run 12			
				Data Qualifier	Reason	=	Result	Data Qualifier	Reason	=	Result	Data Qualifier	Reason	=	Result	Data Qualifier	Reason	=	Result	Data Qualifier	Reason	=	Result	Data Qualifier	Reason	=	Result
31-F	Run #	Run #	-				7				8				9				10				11				12
31-F	Date of Collection	Date - Col	-				3/15/2003				3/15/2003				5/6/2003				5/6/2003				5/20/2003				5/27/2003
31-F	Date Run (Day 1)	Date - Run					3/16/2003				3/18/2003				5/6/2003				5/8/2003				5/20/2003				5/27/2003
31-F	Lab Name	Lab	-				Soil/Tox				Soil/Tox				Soil/Tox				Soil/Tox				Soil/Tox				Soil/Tox
31-F	Water Source	Source	-				HY89+Boxes				Ski Run				HY89+Boxes				Ski Run				On-site				Snow Yard
31-F	QC Type	QC-T	-				N/A				N/A				N/A				N/A				N/A				N/A
31-F	QC Reference (dup of sample)	QC-R	-				N/A				N/A				N/A				N/A				N/A				N/A
31-F	Unit (Sed., Filter, Mechanized, etc.)	Unit					Filter				Sed.				Sed.				Sed.				Sed.				Sed.
31-F	Chemical	Chem.	-				None				None				None				None				None				None
31-F	Chemical Dose	Chem. Dose	mg/L				None				None				None				None				None				None
31-F	Sedimentation Time	Sed. Time	hours				24				24				24				24				24				24
31-F	Filter Media	Media	-				Fine Sand				Fine Sand				Fine Sand				Fine Sand				Fine Sand				Fine Sand
31-F	Filter Loading (6 hour or "fast")	Loading	-				6 hr.				6 hr.				6 hr.				6 hr.				6 hr.				6 hr.
31-F	Filter Outlet (free or submerged)	Filt. Outlet	-				Free				Free				Free				Free				Free				Free
31-F	Pilot Plant ID #	Plant ID#	-				07-31-F				08-31-F				09-31-F				10-31-F				11-31-F				12-31-F
31-F	Laboratory Log #	Lab #	-				T303046-26				T303052-23				T-305008-18				T-305011-08				T-305028-20				T-305040-23
31-F	Alkalinity - total	Alk-T	mg-$CaCO_3$/L				36				31	U	x		45				61				28				34
31-F	Aluminum - acid soluble	Al-AS	µg/L				245				110				87			<	25				530	R	Q		340
31-F	Aluminum - dissolved	Al-D	µg/L			<	25			<	25			<	25			<	25			<	25	R	Q		970
31-F	Aluminum - total	Al-T	µg/L				4200				1700				410				97				8200	J	m		17000
31-F	Ammonia	NH_4	mg-N/L			<	0.1			<	0.1			<	0.1			<	0.1			<	0.1			<	0.1
31-F	Conductivity (field)	EC	µmhos/cm				589				267				308				280				1328				345
31-F	Iron - dissolved	Fe-D	µg/L				29			<	25				99				28			<	25				520
31-F	Iron - total	Fe-T	µg/L				3600				1800				1400				170	J	m		9400				14000
31-F	Kjeldahl Nitrogen - dissolved	TKN-D	mg-N/L	U	x		0.43				0.44	U	x		0.48	U	x		0.17	U	x		0.13	U	x		0.44
31-F	Kjeldahl Nitrogen - total	TKN-T	mg-N/L				0.56				0.39	J	d		0.44	U	x		0.21	U	x		0.34				0.64
31-F	Nitrate Nitrogen	NO_3	mg-N/L			<	0.1			<	0.1				0.24			<	0.1				0.17			<	0.1
31-F	Nitrite Nitrogen	NO_2	mg-N/L			<	0.1			<	0.1			<	0.1			<	0.1			<	0.1			<	0.1
31-F	Oil & Grease	O&G	mg/L			<	2			<	2			<	2			<	2			<	2			<	2
31-F	Organic Carbon - total	TOC	mg/L	J	m		14				11				11				5.6				12				15
31-F	Orthophosphate - dissolved	OP-D	mg-P/L			<	0.03				0.04			<	0.03			<	0.03				0.04				0.03
31-F	Orthophosphate - total	OP-T	mg-P/L				0.14				0.07	U	x		0.06				0.04				0.20				0.21
31-F	pH (field)	pH	pH Units				7.1				7.4				7.5				7.9				7.6				7.6
31-F	Phosphorus - dissolved	Phos-D	mg-P/L				0.05				0.08				0.06				0.04				0.07				0.10
31-F	Phosphorus - total	Phos-T	mg-P/L				0.25				0.15				0.13				0.04	AA		<	0.3				0.64
31-F	Temperature (field)	Temp	°C				3.5				6.5				7.7				7.6				12.9				16.0
31-F	Total Dissolved Solids	TDS	mg/L				330				162				178				172	U	x		790				304
31-F	Total Nitrogen (calculated)	TN	mg-N/L				0.56				0.39				0.68				0.21				0.51				0.64
31-F	Total Suspended Solids	TSS	mg/L				54				22				10				2				114				68
31-F	Turbidity (field)	Turb	NTU				198				54.2				27.8				3.3				246				381

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Phase II Water Quality Data, 2003

Treatment Designation	PARAMETER	ABV.	UNITS	Run 7		Run 8		Run 9		Run 10		Run 11		Run 12	
				Data Qualifier	Result Reason =	Data Qualifier	Result Reason =	Data Qualifier	Result Reason =	Data Qualifier	Result Reason =	Data Qualifier	Result Reason =	Data Qualifier	Result Reason =
32-S	Run #	Run #	-		7		8		9		10		11		12
32-S	Date of Collection	Date - Col	-		3/15/2003		3/15/2003		5/6/2003		5/6/2003		5/20/2003		5/27/2003
32-S	Date Run (Day 1)	Date - Run			3/16/2003		3/18/2003		5/6/2003		5/8/2003		5/20/2003		5/27/2003
32-S	Lab Name	Lab	-		Soil/Tox		Soil/Tox		Soil/Tox		Soil/Tox		Soil/Tox		Soil/Tox
32-S	Water Source	Source	-		HY89+Boxes		Ski Run		HY89+Boxes		Ski Run		On-site		Snow Yard
32-S	QC Type	QC-T	-		N/A		N/A		N/A		N/A		N/A		N/A
32-S	QC Reference (dup of sample)	QC-R	-		N/A		N/A		N/A		N/A		N/A		N/A
32-S	Unit (Sed., Filter, Mechanized, etc.)	Unit			Sed.		Sed.		Sed.		Sed.		Sed.		Sed.
32-S	Chemical	Chem.	-		None		None		None		None		None		None
32-S	Chemical Dose	Chem. Dose	mg/L		None		None		None		None		None		None
32-S	Sedimentation Time	Sed. Time	hours		2		2		2		2		2		2
32-S	Filter Media	Media	-		N/A		N/A		N/A		N/A		N/A		N/A
32-S	Filter Loading (6 hour or "fast")	Loading	-		N/A		N/A		N/A		N/A		N/A		N/A
32-S	Filter Outlet (free or submerged)	Filt. Outlet	-		N/A		N/A		N/A		N/A		N/A		N/A
32-S	Pilot Plant ID #	Plant ID#	-		Not Sampled		Not Sampled		Not Sampled		Not Sampled		Not Sampled		Not Sampled
32-S	Laboratory Log #	Lab #	-												
32-S	Alkalinity - total	Alk-T	mg-$CaCO_3$/L												
32-S	Aluminum - acid soluble	Al-AS	µg/L												
32-S	Aluminum - dissolved	Al-D	µg/L												
32-S	Aluminum - total	Al-T	µg/L												
32-S	Ammonia	NH_4	mg-N/L												
32-S	Conductivity (field)	EC	µmhos/cm												
32-S	Iron - dissolved	Fe-D	µg/L												
32-S	Iron - total	Fe-T	µg/L												
32-S	Kjeldahl Nitrogen - dissolved	TKN-D	mg-N/L												
32-S	Kjeldahl Nitrogen - total	TKN-T	mg-N/L												
32-S	Nitrate Nitrogen	NO_3	mg-N/L												
32-S	Nitrite Nitrogen	NO_2	mg-N/L												
32-S	Oil & Grease	O&G	mg/L												
32-S	Organic Carbon - total	TOC	mg/L												
32-S	Orthophosphate - dissolved	OP-D	mg-P/L												
32-S	Orthophosphate - total	OP-T	mg-P/L												
32-S	pH (field)	pH	pH Units												
32-S	Phosphorus - dissolved	Phos-D	mg-P/L												
32-S	Phosphorus - total	Phos-T	mg-P/L												
32-S	Temperature (field)	Temp	°C												
32-S	Total Dissolved Solids	TDS	mg/L												
32-S	Total Nitrogen (calculated)	TN	mg-N/L												
32-S	Total Suspended Solids	TSS	mg/L												
32-S	Turbidity (field)	Turb	NTU												

Caltrans Lake Tahoe Small-Scale Storm Water Treatment Pilot Plant

Phase II Water Quality Data, 2003

Treatment Designation	PARAMETER	ABV.	UNITS	Run 7				Run 8				Run 9				Run 10				Run 11				Run 12			
				Data Qualifier	Reason	=	Result	Data Qualifier	Reason	=	Result	Data Qualifier	Reason	=	Result	Data Qualifier	Reason	=	Result	Data Qualifier	Reason	=	Result	Data Qualifier	Reason	=	Result
32-F	Run #	Run #	-				7				8				9				10				11				12
32-F	Date of Collection	Date - Col	-				3/15/2003				3/15/2003				5/6/2003				5/6/2003				5/20/2003				5/27/2003
32-F	Date Run (Day 1)	Date - Run					3/16/2003				3/18/2003				5/6/2003				5/8/2003				5/20/2003				5/27/2003
32-F	Lab Name	Lab	-				Soil/Tox				Soil/Tox				Soil/Tox				Soil/Tox				Soil/Tox				Soil/Tox
32-F	Water Source	Source	-				HY89+Boxes				Ski Run				HY89+Boxes				Ski Run				On-site				Snow Yard
32-F	QC Type	QC-T	-				N/A				N/A				N/A				N/A				N/A				N/A
32-F	QC Reference (dup of sample)	QC-R	-				N/A				N/A				N/A				N/A				N/A				N/A
32-F	Unit (Sed., Filter, Mechanized, etc.)	Unit					Filter				Sed.				Sed.				Sed.				Sed.				Sed.
32-F	Chemical	Chem.	-				None				None				None				None				None				None
32-F	Chemical Dose	Chem. Dose	mg/L				None				None				None				None				None				None
32-F	Sedimentation Time	Sed. Time	hours				2				2				2				2				2				2
32-F	Filter Media	Media	-				Fine Sand				Fine Sand				Fine Sand				Fine Sand				Fine Sand				Fine Sand
32-F	Filter Loading (6 hour or "fast")	Loading	-				6 hr.				6 hr.				6 hr.				6 hr.				6 hr.				6 hr.
32-F	Filter Outlet (free or submerged)	Filt. Outlet	-				Free				Free				Free				Free				Free				Free
32-F	Pilot Plant ID #	Plant ID#	-				07-32-F				08-32-F				09-32-F				10-32-F				11-32-F				12-32-F
32-F	Laboratory Log #	Lab #	-				T303046-10				T303052-11				T-305008-15				T-305011-09				T-305028-08				T-305040-13
32-F	Alkalinity - total	Alk-T	mg-$CaCO_3$/L				36				31	U	x		45				60				28				33
32-F	Aluminum - acid soluble	Al-AS	µg/L				404				140				100			<	25				400				460
32-F	Aluminum - dissolved	Al-D	µg/L			<	25			<	25			<	25			<	25			<	25			<	25
32-F	Aluminum - total	Al-T	µg/L				4500				2200				1100				110				10000	J	m		15000
32-F	Ammonia	NH_4	mg-N/L			<	0.1			<	0.1			<	0.1			<	0.1			<	0.1			<	0.1
32-F	Conductivity (field)	EC	µmhos/cm				600				293				314				286				1328				355
32-F	Iron - dissolved	Fe-D	µg/L				31			<	25				100				26			<	25			<	25
32-F	Iron - total	Fe-T	µg/L				4300				2000				1300				160				8100				15000
32-F	Kjeldahl Nitrogen - dissolved	TKN-D	mg-N/L	U	x		0.20				0.39	U	x		0.33	U	x		0.27	U	x		0.14	U	x		0.27
32-F	Kjeldahl Nitrogen - total	TKN-T	mg-N/L				0.59				0.40	J	d		0.39	U	x		0.22	UJ	d,x		0.47				0.73
32-F	Nitrate Nitrogen	NO_3	mg-N/L				0.12			<	0.1				0.26	UJ	h	<	0.1				0.16			<	0.1
32-F	Nitrite Nitrogen	NO_2	mg-N/L			<	0.1			<	0.1			<	0.1	UJ	h	<	0.1			<	0.1			<	0.1
32-F	Oil & Grease	O&G	mg/L			<	3			<	2			<	2			<	2			<	2			<	2
32-F	Organic Carbon - total	TOC	mg/L				13				9				11				5.9				12				16
32-F	Orthophosphate - dissolved	OP-D	mg-P/L				0.03				0.04				0.04	J	h		0.04				0.05			<	0.03
32-F	Orthophosphate - total	OP-T	mg-P/L				0.17				0.11	U	x		0.07	J	h		0.04				0.19				0.20
32-F	pH (field)	pH	pH Units				7.8				7.2				7.5				7.8				7.5				7.6
32-F	Phosphorus - dissolved	Phos-D	mg-P/L				0.05				0.07				0.05				0.07				0.07				0.06
32-F	Phosphorus - total	Phos-T	mg-P/L				0.16				0.21				0.12				0.09				0.31				0.63
32-F	Temperature (field)	Temp	°C				4.6				4.9				8.2				7.9				11.2				14.3
32-F	Total Dissolved Solids	TDS	mg/L				316				176				176				156	U	x		766				336
32-F	Total Nitrogen (calculated)	TN	mg-N/L				0.71				0.40				0.65				0.22				0.63				0.73
32-F	Total Suspended Solids	TSS	mg/L				76				22				12				2				106				60
32-F	Turbidity (field)	Turb	NTU				129				62.1				29.2				3.4				230				392

Caltrans Lake Tahoe Small-Scale Storm Water Treatment Pilot Plant

Phase II Water Quality Data, 2003

Treatment Designation	PARAMETER	ABV.	UNITS	Run 7				Run 8				Run 9				Run 10				Run 11				Run 12			
				Data Qualifier	Reason	=	Result	Data Qualifier	Reason	=	Result	Data Qualifier	Reason	=	Result	Data Qualifier	Reason	=	Result	Data Qualifier	Reason	=	Result	Data Qualifier	Reason	=	Result
33-S	Run #	Run #	-				7				8				9				10				11				12
33-S	Date of Collection	Date - Col	-				3/15/2003				3/15/2003				5/6/2003				5/6/2003				5/20/2003				5/27/2003
33-S	Date Run (Day 1)	Date - Run					3/16/2003				3/18/2003				5/6/2003				5/8/2003				5/20/2003				5/27/2003
33-S	Lab Name	Lab	-				Soil/Tox				Soil/Tox				Soil/Tox				Soil/Tox				Soil/Tox				Soil/Tox
33-S	Water Source	Source	-				HY89+Boxes				Ski Run				HY89+Boxes				Ski Run				On-site				Snow Yard
33-S	QC Type	QC-T	-				N/A				N/A				N/A				N/A				N/A				N/A
33-S	QC Reference (dup of sample)	QC-R	-				N/A				N/A				N/A				N/A				N/A				N/A
33-S	Unit (Sed., Filter, Mechanized, etc.)	Unit					Sed.				Sed.				Sed.				Sed.				Sed.				Sed.
33-S	Chemical	Chem.	-				None				None				None				None				None				None
33-S	Chemical Dose	Chem. Dose	mg/L				None				None				None				None				None				None
33-S	Sedimentation Time	Sed. Time	hours				2				2				2				2				2				2
33-S	Filter Media	Media	-				N/A				N/A				N/A				N/A				N/A				N/A
33-S	Filter Loading (6 hour or "fast")	Loading	-				N/A				N/A				N/A				N/A				N/A				N/A
33-S	Filter Outlet (free or submerged)	Filt. Outlet	-				N/A				N/A				N/A				N/A				N/A				N/A
33-S	Pilot Plant ID #	Plant ID#	-				07-33-S				08-33-S				09-33-S				10-33-S				11-33-S				12-33-S
33-S	Laboratory Log #	Lab #	-				T303046-06				T303052-05				T-305008-02				T-305011-11				T-305028-01				T-305040-14
33-S	Alkalinity - total	Alk-T	mg-$CaCO_3$/L				30				28	U	x		36				63				14				29
33-S	Aluminum - acid soluble	Al-AS	µg/L				403				230				120			<	25				400				370
33-S	Aluminum - dissolved	Al-D	µg/L				25			<	25			<	25			<	25			<	25				94
33-S	Aluminum - total	Al-T	µg/L				8400				4600				1900				290				14000	J	m		16000
33-S	Ammonia	NH_4	mg-N/L			<	0.1			<	0.1				0.12			<	0.1			<	0.1			<	0.1
33-S	Conductivity (field)	EC	µmhos/cm				594				238				293				281				1396				263
33-S	Iron - dissolved	Fe-D	µg/L				47			<	25				110				40			<	25				320
33-S	Iron - total	Fe-T	µg/L				8000				4600				1600				400				15000				18000
33-S	Kjeldahl Nitrogen - dissolved	TKN-D	mg-N/L	U	x		0.18				0.37	U	x		0.50	U	x		0.24	U	x		0.50	U	x		0.21
33-S	Kjeldahl Nitrogen - total	TKN-T	mg-N/L				1.2				0.74	J	d		0.60	U	x		0.23	J	d		0.83				0.88
33-S	Nitrate Nitrogen	NO_3	mg-N/L			<	0.1			<	0.1			<	0.1	UJ	h	<	0.1			<	0.1			<	0.1
33-S	Nitrite Nitrogen	NO_2	mg-N/L			<	0.1			<	0.1			<	0.1	UJ	h	<	0.1			<	0.1			<	0.1
33-S	Oil & Grease	O&G	mg/L				9				3			<	2			<	2				4			<	2
33-S	Organic Carbon - total	TOC	mg/L				16				11				12				5.7				11				20
33-S	Orthophosphate - dissolved	OP-D	mg-P/L			<	0.03			<	0.03			<	0.03	UJ	h	<	0.03				0.04			<	0.03
33-S	Orthophosphate - total	OP-T	mg-P/L				0.26				0.16	U	x		0.05	UJ	h	<	0.03				0.53				0.19
33-S	pH (field)	pH	pH Units				7.8				6.8				7.0				7.9				7.4				7.3
33-S	Phosphorus - dissolved	Phos-D	mg-P/L			<	0.03				0.05			<	0.03				0.07				0.05			<	0.03
33-S	Phosphorus - total	Phos-T	mg-P/L				0.34				0.60				0.14				0.10				0.68				0.79
33-S	Temperature (field)	Temp	°C				4.0				4.5				7.9				7.8				12.1				14.4
33-S	Total Dissolved Solids	TDS	mg/L				308				156				160				178	U	x		788				292
33-S	Total Nitrogen (calculated)	TN	mg-N/L				1.2				0.74				0.60				0.23				0.83				0.88
33-S	Total Suspended Solids	TSS	mg/L				238				110				40				12				324				70
33-S	Turbidity (field)	Turb	NTU				243				141				51.0				9.0				450				503

Caltrans Lake Tahoe Small-Scale Storm Water Treatment Pilot Plant

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Treatment Designation	PARAMETER	ABV.	UNITS	Run 7				Run 8				Run 9				Run 10				Run 11				Run 12			
				Data Qualifier	Reason	=	Result	Data Qualifier	Reason	=	Result	Data Qualifier	Reason	=	Result	Data Qualifier	Reason	=	Result	Data Qualifier	Reason	=	Result	Data Qualifier	Reason	=	Result
33-F	Run #	Run #	-				7				8				9				10				11				12
33-F	Date of Collection	Date - Col	-				3/15/2003				3/15/2003				5/6/2003				5/6/2003				5/20/2003				5/27/2003
33-F	Date Run (Day 1)	Date - Run					3/16/2003				3/18/2003				5/6/2003				5/8/2003				5/20/2003				5/27/2003
33-F	Lab Name	Lab	-				Soil/Tox				Soil/Tox				Soil/Tox				Soil/Tox				Soil/Tox				Soil/Tox
33-F	Water Source	Source	-				HY89+Boxes				Ski Run				HY89+Boxes				Ski Run				On-site				Snow Yard
33-F	QC Type	QC-T	-				N/A				N/A				N/A				N/A				N/A				N/A
33-F	QC Reference (dup of sample)	QC-R	-				N/A				N/A				N/A				N/A				N/A				N/A
33-F	Unit (Sed., Filter, Mechanized, etc.)	Unit					Filter				Sed.				Sed.				Sed.				Sed.				Sed.
33-F	Chemical	Chem.	-				None				None				None				None				None				None
33-F	Chemical Dose	Chem. Dose	mg/L				None				None				None				None				None				None
33-F	Sedimentation Time	Sed. Time	hours				2				2				2				2				2				2
33-F	Filter Media	Media	-				Fine Sand				Fine Sand				Fine Sand				Fine Sand				Fine Sand				Fine Sand
33-F	Filter Loading (6 hour or "fast")	Loading	-				6 hr.				6 hr.				6 hr.				6 hr.				6 hr.				6 hr.
33-F	Filter Outlet (free or submerged)	Filt. Outlet	-				Sub.				Sub.				Sub.				Sub.				Sub.				Sub.
33-F	Pilot Plant ID #	Plant ID#	-				07-33-F				08-33-F				09-33-F				10-33-F				11-33-F				12-33-F
33-F	Laboratory Log #	Lab #	-				T303046-15				T303052-14				T-305008-01				T-305011-10				T-305028-02				T-305040-17
33-F	Alkalinity - total	Alk-T	mg-$CaCO_3$/L				39				32	U	x		47				60				24				36
33-F	Aluminum - acid soluble	Al-AS	µg/L				278				310				78			<	25				240				590
33-F	Aluminum - dissolved	Al-D	µg/L			<	25	U	x		26			<	25			<	25			<	25				26
33-F	Aluminum - total	Al-T	µg/L				3200				1700				860				120				6300	J	m		17000
33-F	Ammonia	NH_4	mg-N/L			<	0.1			<	0.1			<	0.1			<	0.1			<	0.1			<	0.1
33-F	Conductivity (field)	EC	µmhos/cm				650				308				317				277				1307				375
33-F	Iron - dissolved	Fe-D	µg/L			<	25			<	25				88			<	25			<	25			<	25
33-F	Iron - total	Fe-T	µg/L				3000				1600				1000				160				5000				14000
33-F	Kjeldahl Nitrogen - dissolved	TKN-D	mg-N/L	J	Q		0.62				0.38	U	x		0.51	U	x		0.15	U	x		0.19	U	x		0.20
33-F	Kjeldahl Nitrogen - total	TKN-T	mg-N/L	J	Q		0.51				0.50	J	d		0.46	U	x		0.21	UJ	d,x		0.42				0.69
33-F	Nitrate Nitrogen	NO_3	mg-N/L				0.19			<	0.1				0.42	UJ	h	<	0.1				0.25			<	0.1
33-F	Nitrite Nitrogen	NO_2	mg-N/L			<	0.1			<	0.1			<	0.1	UJ	h	<	0.1			<	0.1			<	0.1
33-F	Oil & Grease	O&G	mg/L				2			<	2			<	2			<	2			<	2			<	2
33-F	Organic Carbon - total	TOC	mg/L				13				10				11				5.7				6				17
33-F	Orthophosphate - dissolved	OP-D	mg-P/L				0.05				0.08				0.06	J	h		0.05				0.06				0.10
33-F	Orthophosphate - total	OP-T	mg-P/L				0.14				0.15	U	x		0.09	J	h		0.06				0.15				0.28
33-F	pH (field)	pH	pH Units				7.9				7.2				7.4				7.8				7.5				7.8
33-F	Phosphorus - dissolved	Phos-D	mg-P/L			<	0.03				0.12				0.08				0.06				0.08				0.13
33-F	Phosphorus - total	Phos-T	mg-P/L				0.25				0.19				0.15				0.07				0.30				0.73
33-F	Temperature (field)	Temp	°C				5.0				5.5				8.8				7.9				12.8				15.2
33-F	Total Dissolved Solids	TDS	mg/L				352				182				182				150	U	x		796				340
33-F	Total Nitrogen (calculated)	TN	mg-N/L				0.70				0.50				0.88				0.21				0.67				0.69
33-F	Total Suspended Solids	TSS	mg/L				40				16				10			<	1				44				68
33-F	Turbidity (field)	Turb	NTU				90				48.3				24.7				3.9				137				383

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Treatment Designation	PARAMETER	ABV.	UNITS	Run 7				Run 8				Run 9				Run 10				Run 11				Run 12			
				Data Qualifier	Reason	=	Result	Data Qualifier	Reason	=	Result	Data Qualifier	Reason	=	Result	Data Qualifier	Reason	=	Result	Data Qualifier	Reason	=	Result	Data Qualifier	Reason	=	Result
34-S	Run #	Run #	-				7				8				9				10				11				12
34-S	Date of Collection	Date - Col	-				3/15/2003				3/15/2003				5/6/2003				5/6/2003				5/20/2003				5/27/2003
34-S	Date Run (Day 1)	Date - Run					3/16/2003				3/18/2003				5/6/2003				5/8/2003				5/20/2003				5/27/2003
34-S	Lab Name	Lab	-				Soil/Tox				Soil/Tox				Soil/Tox				Soil/Tox				Soil/Tox				Soil/Tox
34-S	Water Source	Source	-				HY89+Boxes				Ski Run				HY89+Boxes				Ski Run				On-site				Snow Yard
34-S	QC Type	QC-T	-				N/A				N/A				N/A				N/A				N/A				N/A
34-S	QC Reference (dup of sample)	QC-R	-				N/A				N/A				N/A				N/A				N/A				N/A
34-S	Unit (Sed., Filter, Mechanized, etc.)	Unit					Sed.				Sed.				Sed.				Sed.				Sed.				Sed.
34-S	Chemical	Chem.	-				Pass C				Pass C				Pass C				Pass C				Pass C				Pass C
34-S	Chemical Dose	Chem. Dose	mg/L				75				75				170				200				100				120
34-S	Sedimentation Time	Sed. Time	hours				2				2				2				2				2				2
34-S	Filter Media	Media	-				N/A				N/A				N/A				N/A				N/A				N/A
34-S	Filter Loading (6 hour or "fast")	Loading	-				N/A				N/A				N/A				N/A				N/A				N/A
34-S	Filter Outlet (free or submerged)	Filt. Outlet	-				N/A				N/A				N/A				N/A				N/A				N/A
34-S	Pilot Plant ID #	Plant ID#	-				07-34-S				08-34-S				09-34-S				10-34-S				11-34-S				12-34-S
34-S	Laboratory Log #	Lab #	-				T303046-11				T303052-13				T-305008-09				T-305011-13				T-305028-04				T-305040-10
34-S	Alkalinity - total	Alk-T	mg-$CaCO_3$/L				22				19	U	x		20				39				14				18
34-S	Aluminum - acid soluble	Al-AS	µg/L				483				600				1400				1400				430				510
34-S	Aluminum - dissolved	Al-D	µg/L			<	25			<	25			<	25			<	25			<	25			<	25
34-S	Aluminum - total	Al-T	µg/L				2000				1900				1700				1300				2900	J	m		3500
34-S	Ammonia	NH_4	mg-N/L				0.11			<	0.1				0.15			<	0.1			<	0.1			<	0.1
34-S	Conductivity (field)	EC	µmhos/cm				601				277				322				320				1434				295
34-S	Iron - dissolved	Fe-D	µg/L			<	25			<	25			<	25			<	25			<	25			<	25
34-S	Iron - total	Fe-T	µg/L				970				910				300				41				1700				2300
34-S	Kjeldahl Nitrogen - dissolved	TKN-D	mg-N/L	U	x		0.35				0.19	UJ	Q,x		0.53	UJ	Q,x		0.28	U	x		0.18	UJ	d,x		0.24
34-S	Kjeldahl Nitrogen - total	TKN-T	mg-N/L				0.33				0.23	J	d,Q		0.33	UJ	Q,x		0.17	UJ	d,x		0.14	U	x		0.23
34-S	Nitrate Nitrogen	NO_3	mg-N/L				0.12			<	0.1			<	0.1	UJ	h	<	0.1			<	0.1			<	0.1
34-S	Nitrite Nitrogen	NO_2	mg-N/L			<	0.1			<	0.1			<	0.1	UJ	h	<	0.1			<	0.1			<	0.1
34-S	Oil & Grease	O&G	mg/L			<	3			<	2			<	2			<	2			<	2			<	2
34-S	Organic Carbon - total	TOC	mg/L				7				7				7				2.8				2				4
34-S	Orthophosphate - dissolved	OP-D	mg-P/L			<	0.03			<	0.03			<	0.03	UJ	h	<	0.03			<	0.03			<	0.03
34-S	Orthophosphate - total	OP-T	mg-P/L				0.04			<	0.03			<	0.03	UJ	h	<	0.03				0.07			<	0.03
34-S	pH (field)	pH	pH Units				7.4				6.6				6.5				7.0				6.6				6.8
34-S	Phosphorus - dissolved	Phos-D	mg-P/L			<	0.03			<	0.03			<	0.03				0.11			<	0.03			<	0.03
34-S	Phosphorus - total	Phos-T	mg-P/L				0.08				0.09			<	0.03				0.03				0.12				0.10
34-S	Temperature (field)	Temp	°C				4.1				4.9				8.2				7.8				10.9				14.3
34-S	Total Dissolved Solids	TDS	mg/L				306				158				156				196	U	x		802				134
34-S	Total Nitrogen (calculated)	TN	mg-N/L				0.45				0.23				0.33				0.17				0.14				0.23
34-S	Total Suspended Solids	TSS	mg/L				32				26				14				12				42				40
34-S	Turbidity (field)	Turb	NTU				31				24.3				8.2				1.2				43.3				55.4

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Treatment Designation	PARAMETER	ABV.	UNITS	Run 7				Run 8				Run 9				Run 10				Run 11				Run 12			
				Data Qualifier	Reason	=	Result	Data Qualifier	Reason	=	Result	Data Qualifier	Reason	=	Result	Data Qualifier	Reason	=	Result	Data Qualifier	Reason	=	Result	Data Qualifier	Reason	=	Result
34-F	Run #	Run #	-				7				8				9				10				11				12
34-F	Date of Collection	Date - Col	-				3/15/2003				3/15/2003				5/6/2003				5/6/2003				5/20/2003				5/27/2003
34-F	Date Run (Day 1)	Date - Run					3/16/2003				3/18/2003				5/6/2003				5/8/2003				5/20/2003				5/27/2003
34-F	Lab Name	Lab	-				Soil/Tox				Soil/Tox				Soil/Tox				Soil/Tox				Soil/Tox				Soil/Tox
34-F	Water Source	Source	-				HY89+Boxes				Ski Run				HY89+Boxes				Ski Run				On-site				Snow Yard
34-F	QC Type	QC-T	-				N/A				N/A				N/A				N/A				N/A				N/A
34-F	QC Reference (dup of sample)	QC-R	-				N/A				N/A				N/A				N/A				N/A				N/A
34-F	Unit (Sed., Filter, Mechanized, etc.)	Unit					Filter				Filter				Filter				Filter				Filter				Filter
34-F	Chemical	Chem.	-				Pass C				Pass C				Pass C				Pass C				Pass C				Pass C
34-F	Chemical Dose	Chem. Dose	mg/L				to sed tank				to sed tank				to sed tank				to sed tank				to sed tank				to sed tank
34-F	Sedimentation Time	Sed. Time	hours				2				2				2				2				2				2
34-F	Filter Media	Media	-				Fine Sand				Fine Sand				Fine Sand				Fine Sand				Fine Sand				Fine Sand
34-F	Filter Loading (6 hour or "fast")	Loading	-				6 hr.				6 hr.				6 hr.				6 hr.				6 hr.				6 hr.
34-F	Filter Outlet (free or submerged)	Filt. Outlet	-				Free				Free				Free				Free				Free				Free
34-F	Pilot Plant ID #	Plant ID#	-				07-34-F				08-34-F				09-34-F				10-34-F				11-34-F				12-34-F
34-F	Laboratory Log #	Lab #	-				T303046-08				T303052-10				T-305008-10				T-305011-12				T-305028-03				T-305040-15
34-F	Alkalinity - total	Alk-T	mg-$CaCO_3$/L				30				24			<	1				41				17				22
34-F	Aluminum - acid soluble	Al-AS	µg/L			<	25			<	25			<	25			<	25			<	25				27
34-F	Aluminum - dissolved	Al-D	µg/L			<	25			<	25			<	25			<	25			<	25			<	25
34-F	Aluminum - total	Al-T	µg/L			<	25				25			<	25			<	25			<	25	J	m	<	25
34-F	Ammonia	NH_4	mg-N/L			<	0.1			<	0.1				0.11			<	0.1				0.16			<	0.1
34-F	Conductivity (field)	EC	µmhos/cm				630				335				359				333				1368				391
34-F	Iron - dissolved	Fe-D	µg/L			<	25			<	25			<	25			<	25			<	25			<	25
34-F	Iron - total	Fe-T	µg/L			<	25			<	25			<	25			<	25			<	25			<	25
34-F	Kjeldahl Nitrogen - dissolved	TKN-D	mg-N/L	U	x		0.28				0.26	U	x		0.28	U	x		0.22	U	x		0.25	U	x		0.29
34-F	Kjeldahl Nitrogen - total	TKN-T	mg-N/L				0.24				0.19	J	d		0.25	U	x		0.17	UJ	d,x		0.22	U	x		0.21
34-F	Nitrate Nitrogen	NO_3	mg-N/L				0.13			<	0.1				0.12	UJ	h	<	0.1			<	0.1			<	0.1
34-F	Nitrite Nitrogen	NO_2	mg-N/L			<	0.1			<	0.1			<	0.1	UJ	h	<	0.1			<	0.1			<	0.1
34-F	Oil & Grease	O&G	mg/L			<	2			<	2			<	2			<	2			<	2			<	2
34-F	Organic Carbon - total	TOC	mg/L				6				5				5				2.9				1				2
34-F	Orthophosphate - dissolved	OP-D	mg-P/L			<	0.03			<	0.03			<	0.03	UJ	h	<	0.03			<	0.03				0.03
34-F	Orthophosphate - total	OP-T	mg-P/L				0.04			<	0.03			<	0.03	UJ	h	<	0.03				0.04				0.04
34-F	pH (field)	pH	pH Units				7.5				7.1				6.9				7.2				7.1				7.2
34-F	Phosphorus - dissolved	Phos-D	mg-P/L				0.03				0.04			<	0.03				0.07				0.04				0.04
34-F	Phosphorus - total	Phos-T	mg-P/L			<	0.03				0.06				0.05				0.09				0.05				0.05
34-F	Temperature (field)	Temp	°C				4.6				5.0				8.1				7.9				11.3				14.3
34-F	Total Dissolved Solids	TDS	mg/L				312				168				170				190	U	x		734				194
34-F	Total Nitrogen (calculated)	TN	mg-N/L				0.37				0.19				0.37				0.17				0.22				0.21
34-F	Total Suspended Solids	TSS	mg/L	U	x		2			<	1			<	1			<	1			<	1			<	1
34-F	Turbidity (field)	Turb	NTU				0.5				0.3				0.38				0.38				0.19				0.36

Caltrans Lake Tahoe Small-Scale Storm Water Treatment Pilot Plant

Phase II Water Quality Data, 2003

Treatment Designation	PARAMETER	ABV.	UNITS	Run 7				Run 8				Run 9				Run 10				Run 11				Run 12			
				Data Qualifier	Reason	=	Result	Data Qualifier	Reason	=	Result	Data Qualifier	Reason	=	Result	Data Qualifier	Reason	=	Result	Data Qualifier	Reason	=	Result	Data Qualifier	Reason	=	Result
35-S	Run #	Run #	-				7				8				9				10				11				12
35-S	Date of Collection	Date - Col	-				3/15/2003				3/15/2003				5/6/2003				5/6/2003				5/20/2003				5/27/2003
35-S	Date Run (Day 1)	Date - Run					3/16/2003				3/18/2003				5/6/2003				5/8/2003				5/20/2003				5/27/2003
35-S	Lab Name	Lab	-				Soil/Tox				Soil/Tox				Soil/Tox				Soil/Tox				Soil/Tox				Soil/Tox
35-S	Water Source	Source	-				HY89+Boxes				Ski Run				HY89+Boxes				Ski Run				On-site				Snow Yard
35-S	QC Type	QC-T	-				N/A				N/A				N/A				N/A				N/A				N/A
35-S	QC Reference (dup of sample)	QC-R	-				N/A				N/A				N/A				N/A				N/A				N/A
35-S	Unit (Sed., Filter, Mechanized, etc.)	Unit					Sed.				Sed.				Sed.				Sed.				Sed.				Sed.
35-S	Chemical	Chem.	-				None				None				None				None				None				None
35-S	Chemical Dose	Chem. Dose	mg/L				None				None				None				None				None				None
35-S	Sedimentation Time	Sed. Time	hours				2				2				2				2				2				2
35-S	Filter Media	Media	-				N/A				N/A				N/A				N/A				N/A				N/A
35-S	Filter Loading (6 hour or "fast")	Loading	-				N/A				N/A				N/A				N/A				N/A				N/A
35-S	Filter Outlet (free or submerged)	Filt. Outlet	-				N/A				N/A				N/A				N/A				N/A				N/A
35-S	Pilot Plant ID #	Plant ID#	-				07-35-S				08-35-S				09-35-S				10-35-S				11-35-S				12-35-S
35-S	Laboratory Log #	Lab #	-				T303046-07				T303052-06				T-305008-07				T-305011-15				T-305028-06				T-305040-12
35-S	Alkalinity - total	Alk-T	mg-$CaCO_3$/L				29				27	U	x		37				63				7				30
35-S	Aluminum - acid soluble	Al-AS	µg/L				490				250				130			<	25				460				720
35-S	Aluminum - dissolved	Al-D	µg/L			<	25			<	25				120			<	25			<	25			<	25
35-S	Aluminum - total	Al-T	µg/L				11000				5900				590				390				16000	J	m		22000
35-S	Ammonia	NH_4	mg-N/L				0.1			<	0.1				0.14			<	0.1			<	0.1			<	0.1
35-S	Conductivity (field)	EC	µmhos/cm				568				232				290				278				1408				255
35-S	Iron - dissolved	Fe-D	µg/L				46			<	25				120				44			<	25			<	25
35-S	Iron - total	Fe-T	µg/L				9900				5800				2400				520				18000				21000
35-S	Kjeldahl Nitrogen - dissolved	TKN-D	mg-N/L	U	x		0.34				0.72	U	x		0.55	U	x		0.25	U	x		0.12	U	x		0.23
35-S	Kjeldahl Nitrogen - total	TKN-T	mg-N/L				1.4				0.86	J	d		0.70	U	x		0.22	J	d		0.66				0.97
35-S	Nitrate Nitrogen	NO_3	mg-N/L				0.10			<	0.1	UJ	h	<	0.1	UJ	h	<	0.1			<	0.1			<	0.1
35-S	Nitrite Nitrogen	NO_2	mg-N/L			<	0.1			<	0.1	UJ	h	<	0.1	UJ	h	<	0.1			<	0.1			<	0.1
35-S	Oil & Grease	O&G	mg/L				8				5			<	2			<	2				4			<	2
35-S	Organic Carbon - total	TOC	mg/L				13				13				14				5.9				12				24
35-S	Orthophosphate - dissolved	OP-D	mg-P/L			<	0.03			<	0.03	UJ	h	<	0.03	UJ	h	<	0.03				0.05			<	0.03
35-S	Orthophosphate - total	OP-T	mg-P/L				0.41				0.19	UJ	h,x		0.06	UJ	h	<	0.03				0.64				0.23
35-S	pH (field)	pH	pH Units				8.1				6.9				7.0				7.9				7.5				7.2
35-S	Phosphorus - dissolved	Phos-D	mg-P/L			<	0.03				0.05			<	0.03				0.11				0.07			<	0.03
35-S	Phosphorus - total	Phos-T	mg-P/L				0.50				0.42				0.16				0.11				0.78				0.88
35-S	Temperature (field)	Temp	°C				2.7				6.6				8.5				7.9				8.7				13.4
35-S	Total Dissolved Solids	TDS	mg/L				312				152				162				166	U	x		768				284
35-S	Total Nitrogen (calculated)	TN	mg-N/L				1.5				0.86				0.70				0.22				0.66				0.97
35-S	Total Suspended Solids	TSS	mg/L				338				150				50				18				408				208
35-S	Turbidity (field)	Turb	NTU				405				191				59.5				12.0				538				567

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Treatment Designation	PARAMETER	ABV.	UNITS	Run 7				Run 8				Run 9				Run 10				Run 11				Run 12			
				Data Qualifier	Reason	=	Result	Data Qualifier	Reason	=	Result	Data Qualifier	Reason	=	Result	Data Qualifier	Reason	=	Result	Data Qualifier	Reason	=	Result	Data Qualifier	Reason	=	Result
35-F	Run #	Run #	-				7				8				9				10				11				12
35-F	Date of Collection	Date - Col	-				3/15/2003				3/15/2003				5/6/2003				5/6/2003				5/20/2003				5/27/2003
35-F	Date Run (Day 1)	Date - Run					3/16/2003				3/18/2003				5/6/2003				5/8/2003				5/20/2003				5/27/2003
35-F	Lab Name	Lab	-				Soil/Tox				Soil/Tox				Soil/Tox				Soil/Tox				Soil/Tox				Soil/Tox
35-F	Water Source	Source	-				HY89+Boxes				Ski Run				HY89+Boxes				Ski Run				On-site				Snow Yard
35-F	QC Type	QC-T	-				N/A				N/A				N/A				N/A				N/A				N/A
35-F	QC Reference (dup of sample)	QC-R	-				N/A				N/A				N/A				N/A				N/A				N/A
35-F	Unit (Sed., Filter, Mechanized, etc.)	Unit					Filter				Filter				Filter				Filter				Filter				Filter
35-F	Chemical	Chem.	-				None				None				None				None				None				None
35-F	Chemical Dose	Chem. Dose	mg/L				None				None				None				None				None				None
35-F	Sedimentation Time	Sed. Time	hours				2				2				2				2				2				2
35-F	Filter Media	Media	-				Fine Sand				Fine Sand				Fine Sand				Fine Sand				Fine Sand				Fine Sand
35-F	Filter Loading (6 hour or "fast")	Loading	-				Fast				Fast				Fast				Fast				Fast				Fast
35-F	Filter Outlet (free or submerged)	Filt. Outlet	-				Free				Free				Free				Free				Free				Free
35-F	Pilot Plant ID #	Plant ID#	-				07-35-F				08-35-F				09-35-F				10-35-F				11-35-F				12-35-F
35-F	Laboratory Log #	Lab #	-				T303046-04				T303052-12				T-305008-11				T-305011-14				T-305028-05				T-305040-11
35-F	Alkalinity - total	Alk-T	mg-$CaCO_3$/L				38				33	U	x		43				61				29				33
35-F	Aluminum - acid soluble	Al-AS	µg/L				362				190				140				28				340				1300
35-F	Aluminum - dissolved	Al-D	µg/L			<	25			<	25			<	25			<	25			<	25				25
35-F	Aluminum - total	Al-T	µg/L				7100				3800				630				570				4600	J	m		19000
35-F	Ammonia	NH_4	mg-N/L			<	0.1			<	0.1			<	0.1			<	0.1			<	0.1			<	0.1
35-F	Conductivity (field)	EC	µmhos/cm				679				319				319				282				1303				395
35-F	Iron - dissolved	Fe-D	µg/L				33			<	25				94				29			<	25			<	25
35-F	Iron - total	Fe-T	µg/L				6100				3700				2000				370				11000				17000
35-F	Kjeldahl Nitrogen - dissolved	TKN-D	mg-N/L	U	x		0.50				0.51	U	x		0.37	U	x		0.24	U	x		0.21	U	x		0.35
35-F	Kjeldahl Nitrogen - total	TKN-T	mg-N/L				0.94				0.62	J	d		0.53	U	x		0.20	UJ	d,x		0.55				0.81
35-F	Nitrate Nitrogen	NO_3	mg-N/L				0.15			<	0.1				0.67	J	h		0.12				0.15			<	0.1
35-F	Nitrite Nitrogen	NO_2	mg-N/L			<	0.1			<	0.1			<	0.1	UJ	h	<	0.1			<	0.1			<	0.1
35-F	Oil & Grease	O&G	mg/L				3				2			<	2			<	2			<	2			<	2
35-F	Organic Carbon - total	TOC	mg/L				11				10				11				6.2				11				18
35-F	Orthophosphate - dissolved	OP-D	mg-P/L			<	0.03				0.04				0.03	J	h		0.04				0.05			<	0.03
35-F	Orthophosphate - total	OP-T	mg-P/L				0.26				0.17	U	x		0.06	J	h		0.04				0.47				0.22
35-F	pH (field)	pH	pH Units				7.6				7.1				7.2				7.9				7.5				7.6
35-F	Phosphorus - dissolved	Phos-D	mg-P/L				0.06				0.07				0.07				0.10				0.08				0.03
35-F	Phosphorus - total	Phos-T	mg-P/L				0.29				0.28				0.17				0.09				0.53				0.78
35-F	Temperature (field)	Temp	°C				4.9				4.7				8.1				8.0				10.4				14.3
35-F	Total Dissolved Solids	TDS	mg/L				344				184				154				164	U	x		704				348
35-F	Total Nitrogen (calculated)	TN	mg-N/L				1.1				0.62				1.2				0.32				0.70				0.81
35-F	Total Suspended Solids	TSS	mg/L				164				70				34				12				262				136
35-F	Turbidity (field)	Turb	NTU				190				117				52.8				12.3				339				483

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Phase II Water Quality Data, 2003

Treatment Designation	PARAMETER	ABV.	UNITS	Run 7				Run 8				Run 9				Run 10				Run 11				Run 12			
				Data Qualifier	Reason	=	Result	Data Qualifier	Reason	=	Result	Data Qualifier	Reason	=	Result	Data Qualifier	Reason	=	Result	Data Qualifier	Reason	=	Result	Data Qualifier	Reason	=	Result
36-S	Run #	Run #	-				7				8				9				10				11				12
36-S	Date of Collection	Date - Col	-				3/15/2003				3/15/2003				5/6/2003				5/6/2003				5/20/2003				5/27/2003
36-S	Date Run (Day 1)	Date - Run					3/16/2003				3/18/2003				5/6/2003				5/8/2003				5/20/2003				5/27/2003
36-S	Lab Name	Lab	-				Soil/Tox				Soil/Tox				Soil/Tox				Soil/Tox				Soil/Tox				Soil/Tox
36-S	Water Source	Source	-				HY89+Boxes				Ski Run				HY89+Boxes				Ski Run				On-site				Snow Yard
36-S	QC Type	QC-T	-				N/A				N/A				N/A				N/A				N/A				N/A
36-S	QC Reference (dup of sample)	QC-R	-				N/A				N/A				N/A				N/A				N/A				N/A
36-S	Unit (Sed., Filter, Mechanized, etc.)	Unit					Sed.				Sed.				Sed.				Sed.				Sed.				Sed.
36-S	Chemical	Chem.	-				None				None				None				None				None				None
36-S	Chemical Dose	Chem. Dose	mg/L				None				None				None				None				None				None
36-S	Sedimentation Time	Sed. Time	hours				24				24				24				24				24				24
36-S	Filter Media	Media	-				N/A				N/A				N/A				N/A				N/A				N/A
36-S	Filter Loading (6 hour or "fast")	Loading	-				N/A				N/A				N/A				N/A				N/A				N/A
36-S	Filter Outlet (free or submerged)	Filt. Outlet	-				N/A				N/A				N/A				N/A				N/A				N/A
36-S	Pilot Plant ID #	Plant ID#	-				07-36-S				08-36-S				09-36-S				10-36-S				11-36-S				12-36-S
36-S	Laboratory Log #	Lab #	-				T303046-28				T303052-25				T-305008-20				T-305011-17				T-305028-22				T-305040-25
36-S	Alkalinity - total	Alk-T	mg-$CaCO_3$/L				31				28	U	x		38				64				24				31
36-S	Aluminum - acid soluble	Al-AS	µg/L				740				190				110			<	25				490				440
36-S	Aluminum - dissolved	Al-D	µg/L			<	25			<	25			<	25			<	25			<	25				69
36-S	Aluminum - total	Al-T	µg/L				6800				2500				1800				140				14000	J	m		21000
36-S	Ammonia	NH_4	mg-N/L			<	0.1			<	0.1				0.11			<	0.1			<	0.1			<	0.1
36-S	Conductivity (field)	EC	µmhos/cm				574				244				285				287				1388				263
36-S	Iron - dissolved	Fe-D	µg/L				37			<	25				96				35			<	25				96
36-S	Iron - total	Fe-T	µg/L				5500				2700				1900				220	J	m		16000				17000
36-S	Kjeldahl Nitrogen - dissolved	TKN-D	mg-N/L	U	x		0.27				0.14	UJ	d,x		0.30	U	x		0.22			<	0.1	U	x		0.28
36-S	Kjeldahl Nitrogen - total	TKN-T	mg-N/L				0.77				0.51	J	d		0.69	U	x		0.23	U	x		0.56				0.73
36-S	Nitrate Nitrogen	NO_3	mg-N/L			<	0.1			<	0.1			<	0.1			<	0.1			<	0.1			<	0.1
36-S	Nitrite Nitrogen	NO_2	mg-N/L			<	0.1			<	0.1			<	0.1			<	0.1			<	0.1			<	0.1
36-S	Oil & Grease	O&G	mg/L			<	4			<	2			<	2			<	2				4			<	2
36-S	Organic Carbon - total	TOC	mg/L	J	m		22				13				13				5.7				23				22
36-S	Orthophosphate - dissolved	OP-D	mg-P/L			<	0.03			<	0.03			<	0.03			<	0.03				0.04			<	0.03
36-S	Orthophosphate - total	OP-T	mg-P/L				0.20				0.08			<	0.03			<	0.03				0.24				0.22
36-S	pH (field)	pH	pH Units				7.0				7.2				7.0				7.9				7.4				7.3
36-S	Phosphorus - dissolved	Phos-D	mg-P/L			<	0.03				0.06			<	0.03				0.07				0.06			<	0.03
36-S	Phosphorus - total	Phos-T	mg-P/L				0.33				0.20				0.13				0.08				0.75				0.79
36-S	Temperature (field)	Temp	°C				3.2				6.0				7.3				7.6				13.8				16.8
36-S	Total Dissolved Solids	TDS	mg/L				318				150				162				168	U	x		764				264
36-S	Total Nitrogen (calculated)	TN	mg-N/L				0.77				0.51				0.69				0.23				0.56				0.73
36-S	Total Suspended Solids	TSS	mg/L				140				42				28			<	1				268				132
36-S	Turbidity (field)	Turb	NTU				198				119				46.4				5.0				392				495

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Phase II Water Quality Data, 2003

Treatment Designation	PARAMETER	ABV.	UNITS	Run 7				Run 8				Run 9				Run 10				Run 11				Run 12			
				Data Qualifier	Reason	=	Result	Data Qualifier	Reason	=	Result	Data Qualifier	Reason	=	Result	Data Qualifier	Reason	=	Result	Data Qualifier	Reason	=	Result	Data Qualifier	Reason	=	Result
36-F	Run #	Run #	-				7				8				9				10				11				12
36-F	Date of Collection	Date - Col	-				3/15/2003				3/15/2003				5/6/2003				5/6/2003				5/20/2003				5/27/2003
36-F	Date Run (Day 1)	Date - Run					3/16/2003				3/18/2003				5/6/2003				5/8/2003				5/20/2003				5/27/2003
36-F	Lab Name	Lab	-				Soil/Tox				Soil/Tox				Soil/Tox				Soil/Tox				Soil/Tox				Soil/Tox
36-F	Water Source	Source	-				HY89+Boxes				Ski Run				HY89+Boxes				Ski Run				On-site				Snow Yard
36-F	QC Type	QC-T	-				N/A				N/A				N/A				N/A				N/A				N/A
36-F	QC Reference (dup of sample)	QC-R	-				N/A				N/A				N/A				N/A				N/A				N/A
36-F	Unit (Sed., Filter, Mechanized, etc.)	Unit					Filter				Filter				Filter				Filter				Filter				Filter
36-F	Chemical	Chem.	-				None				None				None				None				None				None
36-F	Chemical Dose	Chem. Dose	mg/L				None				None				None				None				None				None
36-F	Sedimentation Time	Sed. Time	hours				24				24				24				24				24				24
36-F	Filter Media	Media	-				Fine Sand				Fine Sand				Fine Sand				Fine Sand				Fine Sand				Fine Sand
36-F	Filter Loading (6 hour or "fast")	Loading	-				6 hr.				6 hr.				6 hr.				6 hr.				6 hr.				6 hr.
36-F	Filter Outlet (free or submerged)	Filt. Outlet	-				Sub.				Sub.				Sub.				Sub.				Sub.				Sub.
36-F	Pilot Plant ID #	Plant ID#	-				07-36-F				08-36-F				09-36-F				10-36-F				11-36-F				12-36-F
36-F	Laboratory Log #	Lab #	-				T303046-27				T303052-24				T-305008-19				T-305011-16				T-305028-21				T-305040-24
36-F	Alkalinity - total	Alk-T	mg-$CaCO_3$/L				36				35	U	x		49				59				29				36
36-F	Aluminum - acid soluble	Al-AS	µg/L				183				130				95			<	25				280				340
36-F	Aluminum - dissolved	Al-D	µg/L				37				250			<	25			<	25			<	25				38
36-F	Aluminum - total	Al-T	µg/L				2700				1500				280				92				5000	J	m		15000
36-F	Ammonia	NH_4	mg-N/L			<	0.1			<	0.1			<	0.1			<	0.1			<	0.1			<	0.1
36-F	Conductivity (field)	EC	µmhos/cm				594				301				321				280				1293				381
36-F	Iron - dissolved	Fe-D	µg/L				30				280				81			<	25			<	25			<	25
36-F	Iron - total	Fe-T	µg/L				2400				1500				1100				180	J	m		5800				14000
36-F	Kjeldahl Nitrogen - dissolved	TKN-D	mg-N/L	U	x		0.47				0.21	U	x		0.41	U	x		0.27	U	x		0.17	U	x		0.25
36-F	Kjeldahl Nitrogen - total	TKN-T	mg-N/L				0.50				0.37				0.49	U	x		0.22	U	x		0.31				0.67
36-F	Nitrate Nitrogen	NO_3	mg-N/L				0.11			<	0.1				0.35				0.27				0.25			<	0.1
36-F	Nitrite Nitrogen	NO_2	mg-N/L			<	0.1			<	0.1			<	0.1			<	0.1			<	0.1			<	0.1
36-F	Oil & Grease	O&G	mg/L			<	2			<	2			<	2			<	2			<	2			<	2
36-F	Organic Carbon - total	TOC	mg/L	J	m		12				10				11				5.6				8				15
36-F	Orthophosphate - dissolved	OP-D	mg-P/L				0.05				0.07				0.05				0.05				0.04				0.13
36-F	Orthophosphate - total	OP-T	mg-P/L				0.11				0.10	U	x		0.07				0.06				0.13				0.33
36-F	pH (field)	pH	pH Units				7.4				7.8				6.9				7.6				7.7				7.7
36-F	Phosphorus - dissolved	Phos-D	mg-P/L				0.08				0.18				0.09				0.12				0.08				0.14
36-F	Phosphorus - total	Phos-T	mg-P/L				0.22				0.18				0.16				0.11				0.33				0.72
36-F	Temperature (field)	Temp	°C				4.0				6.4				7.5				7.9				13.7				17.8
36-F	Total Dissolved Solids	TDS	mg/L				336				166				180				158	U	x		808				340
36-F	Total Nitrogen (calculated)	TN	mg-N/L				0.61				0.37				0.84				0.49				0.56				0.67
36-F	Total Suspended Solids	TSS	mg/L				30				12				8			<	1				42				68
36-F	Turbidity (field)	Turb	NTU				70				45.8				25.5				4.3				135				385

Caltrans Lake Tahoe Small-Scale Storm Water Treatment Pilot Plant

Phase II Water Quality Data, 2003

Treatment Designation	PARAMETER	ABV.	UNITS	Run 7	Run 8	Run 9	Run 10	Run 11	Run 12
				Data Qualifier Reason = Result	Data Qualifier Reason = Result	Data Qualifier Reason = Result	Data Qualifier Reason = Result	Data Qualifier Reason = Result	Data Qualifier Reason = Result
37-S	Run #	Run #	-	7	8	9	10	11	12
37-S	Date of Collection	Date - Col	-	3/15/2003	3/15/2003	5/6/2003	5/6/2003	5/20/2003	5/27/2003
37-S	Date Run (Day 1)	Date - Run		3/16/2003	3/18/2003	5/6/2003	5/8/2003	5/20/2003	5/27/2003
37-S	Lab Name	Lab	-	Soil/Tox	Soil/Tox	Soil/Tox	Soil/Tox	Soil/Tox	Soil/Tox
37-S	Water Source	Source	-	HY89+Boxes	Ski Run	HY89+Boxes	Ski Run	On-site	Snow Yard
37-S	QC Type	QC-T	-	N/A	N/A	N/A	N/A	N/A	N/A
37-S	QC Reference (dup of sample)	QC-R	-	N/A	N/A	N/A	N/A	N/A	N/A
37-S	Unit (Sed., Filter, Mechanized, etc.)	Unit		Sed.	Sed.	Sed.	Sed.	Sed.	Sed.
37-S	Chemical	Chem.	-	None	None	None	None	None	None
37-S	Chemical Dose	Chem. Dose	mg/L	None	None	None	None	None	None
37-S	Sedimentation Time	Sed. Time	hours	24	24	24	24	24	24
37-S	Filter Media	Media	-	N/A	N/A	N/A	N/A	N/A	N/A
37-S	Filter Loading (6 hour or "fast")	Loading	-	N/A	N/A	N/A	N/A	N/A	N/A
37-S	Filter Outlet (free or submerged)	Filt. Outlet	-	N/A	N/A	N/A	N/A	N/A	N/A
37-S	Pilot Plant ID #	Plant ID#	-	Not Sampled	Not Sampled	Not Sampled	Not Sampled	Not Sampled	Not Sampled
37-S	Laboratory Log #	Lab #	-						
37-S	Alkalinity - total	Alk-T	mg-$CaCO_3$/L						
37-S	Aluminum - acid soluble	Al-AS	µg/L						
37-S	Aluminum - dissolved	Al-D	µg/L						
37-S	Aluminum - total	Al-T	µg/L						
37-S	Ammonia	NH_4	mg-N/L						
37-S	Conductivity (field)	EC	µmhos/cm						
37-S	Iron - dissolved	Fe-D	µg/L						
37-S	Iron - total	Fe-T	µg/L						
37-S	Kjeldahl Nitrogen - dissolved	TKN-D	mg-N/L						
37-S	Kjeldahl Nitrogen - total	TKN-T	mg-N/L						
37-S	Nitrate Nitrogen	NO_3	mg-N/L						
37-S	Nitrite Nitrogen	NO_2	mg-N/L						
37-S	Oil & Grease	O&G	mg/L						
37-S	Organic Carbon - total	TOC	mg/L						
37-S	Orthophosphate - dissolved	OP-D	mg-P/L						
37-S	Orthophosphate - total	OP-T	mg-P/L						
37-S	pH (field)	pH	pH Units						
37-S	Phosphorus - dissolved	Phos-D	mg-P/L						
37-S	Phosphorus - total	Phos-T	mg-P/L						
37-S	Temperature (field)	Temp	°C						
37-S	Total Dissolved Solids	TDS	mg/L						
37-S	Total Nitrogen (calculated)	TN	mg-N/L						
37-S	Total Suspended Solids	TSS	mg/L						
37-S	Turbidity (field)	Turb	NTU						

Caltrans Lake Tahoe Small-Scale Storm Water Treatment Pilot Plant

Phase II Water Quality Data, 2003

Treatment Designation	PARAMETER	ABV.	UNITS	Run 7				Run 8				Run 9				Run 10				Run 11				Run 12			
				Data Qualifier	Reason	=	Result	Data Qualifier	Reason	=	Result	Data Qualifier	Reason	=	Result	Data Qualifier	Reason	=	Result	Data Qualifier	Reason	=	Result	Data Qualifier	Reason	=	Result
37-F	Run #	Run #	-				7				8				9				10				11				12
37-F	Date of Collection	Date - Col	-				3/15/2003				3/15/2003				5/6/2003				5/6/2003				5/20/2003				5/27/2003
37-F	Date Run (Day 1)	Date - Run					3/16/2003				3/18/2003				5/6/2003				5/8/2003				5/20/2003				5/27/2003
37-F	Lab Name	Lab	-				Soil/Tox				Soil/Tox				Soil/Tox				Soil/Tox				Soil/Tox				Soil/Tox
37-F	Water Source	Source	-				HY89+Boxes				Ski Run				HY89+Boxes				Ski Run				On-site				Snow Yard
37-F	QC Type	QC-T	-				N/A				N/A				N/A				N/A				N/A				N/A
37-F	QC Reference (dup of sample)	QC-R	-				N/A				N/A				N/A				N/A				N/A				N/A
37-F	Unit (Sed., Filter, Mechanized, etc.)	Unit					Filter				Filter				Filter				Filter				Filter				Filter
37-F	Chemical	Chem.	-				None				None				None				None				None				None
37-F	Chemical Dose	Chem. Dose	mg/L				None				None				None				None				None				None
37-F	Sedimentation Time	Sed. Time	hours				24				24				24				24				24				24
37-F	Filter Media	Media	-				Exp. Shale				Exp. Shale				Exp. Shale				Exp. Shale				Exp. Shale				Exp. Shale
37-F	Filter Loading (6 hour or "fast")	Loading	-				6 hr.				6 hr.				6 hr.				6 hr.				6 hr.				6 hr.
37-F	Filter Outlet (free or submerged)	Filt. Outlet	-				Sub.				Sub.				Sub.				Sub.				Sub.				Sub.
37-F	Pilot Plant ID #	Plant ID#	-				07-37-F				08-37-F				09-37-F				10-37-F				11-37-F				12-37-F
37-F	Laboratory Log #	Lab #	-				T303046-29				T303052-26				T-305008-21				T-305011-18				T-305028-23				T-305040-26
37-F	Alkalinity - total	Alk-T	mg-$CaCO_3$/L				230				180	U	x		97				98				120				110
37-F	Aluminum - acid soluble	Al-AS	µg/L	J	Q		466				480				270				210				290				500
37-F	Aluminum - dissolved	Al-D	µg/L				340				410				230	J	Q		220	R	Q		710				450
37-F	Aluminum - total	Al-T	µg/L	J	Q		400				460				290	J	Q		190	R	Q		380	J	m		480
37-F	Ammonia	NH_4	mg-N/L				0.12			<	0.1			<	0.1			<	0.1			<	0.1			<	0.1
37-F	Conductivity (field)	EC	µmhos/cm				1296				730				650				490				1471				852
37-F	Iron - dissolved	Fe-D	µg/L			<	25			<	25			<	25			<	25			<	25			<	25
37-F	Iron - total	Fe-T	µg/L			<	25			<	25				38			<	25	UJ	m	<	25				47
37-F	Kjeldahl Nitrogen - dissolved	TKN-D	mg-N/L	U	x		0.16				0.19	UJ	d,x		0.33	U	x		0.19	U	x		0.20	UJ	Q,x		0.37
37-F	Kjeldahl Nitrogen - total	TKN-T	mg-N/L			<	0.1			<	0.1				0.30	U	x		0.17			<	0.1	UJ	Q,x		0.18
37-F	Nitrate Nitrogen	NO_3	mg-N/L			<	0.1			<	0.1			<	0.1			<	0.1			<	0.1			<	0.1
37-F	Nitrite Nitrogen	NO_2	mg-N/L			<	0.1			<	0.1			<	0.1			<	0.1			<	0.1			<	0.1
37-F	Oil & Grease	O&G	mg/L			<	15			<	2			<	2			<	2			<	2			<	2
37-F	Organic Carbon - total	TOC	mg/L	J	m		4				2				4				2.9				1				22
37-F	Orthophosphate - dissolved	OP-D	mg-P/L				0.04			<	0.03			<	0.03			<	0.03			<	0.03			<	0.03
37-F	Orthophosphate - total	OP-T	mg-P/L				0.07			<	0.03			<	0.03			<	0.03			<	0.03			<	0.03
37-F	pH (field)	pH	pH Units				11.5				11.5				11.2				11.3				11.1				10.9
37-F	Phosphorus - dissolved	Phos-D	mg-P/L			<	0.03				0.04				0.03				0.11				0.11				0.04
37-F	Phosphorus - total	Phos-T	mg-P/L				0.03				0.04				0.04				0.05				0.13				0.06
37-F	Temperature (field)	Temp	°C				4.2				6.5				7.4				7.9				13.4				17.1
37-F	Total Dissolved Solids	TDS	mg/L				856				390				416				286	U	x		800				444
37-F	Total Nitrogen (calculated)	TN	mg-N/L			<	0.1			<	0.1				0.30				0.17			<	0.1				0.18
37-F	Total Suspended Solids	TSS	mg/L	U	x		2			<	1			<	1			<	1			<	1			<	1
37-F	Turbidity (field)	Turb	NTU				0.9				0.9				1.5				0.40				0.56				2.2

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Phase II Water Quality Data, 2003

Treatment Designation	PARAMETER	ABV.	UNITS	Run 7				Run 8				Run 9				Run 10				Run 11				Run 12			
				Data Qualifier	Reason	=	Result	Data Qualifier	Reason	=	Result	Data Qualifier	Reason	=	Result	Data Qualifier	Reason	=	Result	Data Qualifier	Reason	=	Result	Data Qualifier	Reason	=	Result
38-S	Run #	Run #	-				7				8				9				10				11				12
38-S	Date of Collection	Date - Col	-				3/15/2003				3/15/2003				5/6/2003				5/6/2003				5/20/2003				5/27/2003
38-S	Date Run (Day 1)	Date - Run					3/16/2003				3/18/2003				5/6/2003				5/8/2003				5/20/2003				5/27/2003
38-S	Lab Name	Lab	-				Soil/Tox				Soil/Tox				Soil/Tox				Soil/Tox				Soil/Tox				Soil/Tox
38-S	Water Source	Source	-				HY89+Boxes				Ski Run				HY89+Boxes				Ski Run				On-site				Snow Yard
38-S	QC Type	QC-T	-				N/A				N/A				N/A				N/A				N/A				N/A
38-S	QC Reference (dup of sample)	QC-R	-				N/A				N/A				N/A				N/A				N/A				N/A
38-S	Unit (Sed., Filter, Mechanized, etc.)	Unit					Sed.				Sed.				Sed.				Sed.				Sed.				Sed.
38-S	Chemical	Chem.	-				None				None				None				None				None				None
38-S	Chemical Dose	Chem. Dose	mg/L				None				None				None				None				None				None
38-S	Sedimentation Time	Sed. Time	hours				24				24				24				24				24				24
38-S	Filter Media	Media	-				N/A				N/A				N/A				N/A				N/A				N/A
38-S	Filter Loading (6 hour or "fast")	Loading	-				N/A				N/A				N/A				N/A				N/A				N/A
38-S	Filter Outlet (free or submerged)	Filt. Outlet	-				N/A				N/A				N/A				N/A				N/A				N/A
38-S	Pilot Plant ID #	Plant ID#	-				07-38-S				08-38-S				09-38-S				10-38-S				11-38-S				12-38-S
38-S	Laboratory Log #	Lab #	-				T303046-31				T303052-28				T-305008-23				T-305011-20				T-305028-25				T-305040-28
38-S	Alkalinity - total	Alk-T	mg-$CaCO_3$/L				29				28	U	x		38				61				25				30
38-S	Aluminum - acid soluble	Al-AS	µg/L				352				260				100			<	25				450				450
38-S	Aluminum - dissolved	Al-D	µg/L			<	25			<	25			<	25			<	25			<	25			<	25
38-S	Aluminum - total	Al-T	µg/L				5900				3100				450				80				13000	J	m		18000
38-S	Ammonia	NH_4	mg-N/L			<	0.1				0.1				0.11			<	0.1			<	0.1			<	0.1
38-S	Conductivity (field)	EC	µmhos/cm				557				230				285				280				1401				261
38-S	Iron - dissolved	Fe-D	µg/L				48			<	25				110				35			<	25			<	25
38-S	Iron - total	Fe-T	µg/L				5700				3300				2000				220	J	m		14000				18000
38-S	Kjeldahl Nitrogen - dissolved	TKN-D	mg-N/L				0.49				0.25	UJ	d,x		0.38	U	x		0.21			<	0.1	UJ	f,x		0.25
38-S	Kjeldahl Nitrogen - total	TKN-T	mg-N/L				0.81				0.63				0.63	U	x		0.24	U	x		0.54				0.76
38-S	Nitrate Nitrogen	NO_3	mg-N/L				0.1			<	0.1			<	0.1				0.61	BB			3.5	R	f		0.42
38-S	Nitrite Nitrogen	NO_2	mg-N/L			<	0.1			<	0.1			<	0.1			<	0.1			<	0.1			<	0.1
38-S	Oil & Grease	O&G	mg/L				4			<	2			<	2			<	2				4			<	2
38-S	Organic Carbon - total	TOC	mg/L	J	m		2				12				13				5.3				20	R	f		29
38-S	Orthophosphate - dissolved	OP-D	mg-P/L			<	0.03			<	0.03			<	0.03			<	0.03				0.04			<	0.03
38-S	Orthophosphate - total	OP-T	mg-P/L				0.19				0.09			<	0.03			<	0.03				0.26				0.20
38-S	pH (field)	pH	pH Units				7.0				7.1				7.0				7.9				7.3				7.3
38-S	Phosphorus - dissolved	Phos-D	mg-P/L			<	0.03				0.06				0.04				0.11				0.05			<	0.03
38-S	Phosphorus - total	Phos-T	mg-P/L				0.33				0.24				0.13				0.07				0.72				0.71
38-S	Temperature (field)	Temp	°C				2.7				5.8				7.5				7.3				12.6				16.8
38-S	Total Dissolved Solids	TDS	mg/L				320				154				164				182	U	x		828				244
38-S	Total Nitrogen (calculated)	TN	mg-N/L				0.91				0.63				0.63				0.85	BB			4.0				1.18
38-S	Total Suspended Solids	TSS	mg/L				132				54				24			<	1				240				124
38-S	Turbidity (field)	Turb	NTU				197				99.3				47.5				5.2				394				476

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Phase II Water Quality Data, 2003

Treatment Designation	PARAMETER	ABV.	UNITS	Run 7				Run 8				Run 9				Run 10				Run 11				Run 12			
				Data Qualifier	Reason	=	Result	Data Qualifier	Reason	=	Result	Data Qualifier	Reason	=	Result	Data Qualifier	Reason	=	Result	Data Qualifier	Reason	=	Result	Data Qualifier	Reason	=	Result
38-F	Run #	Run #	-				7				8				9				10				11				12
38-F	Date of Collection	Date - Col	-				3/15/2003				3/15/2003				5/6/2003				5/6/2003				5/20/2003				5/27/2003
38-F	Date Run (Day 1)	Date - Run					3/16/2003				3/18/2003				5/6/2003				5/8/2003				5/20/2003				5/27/2003
38-F	Lab Name	Lab	-				Soil/Tox				Soil/Tox				Soil/Tox				Soil/Tox				Soil/Tox				Soil/Tox
38-F	Water Source	Source	-				HY89+Boxes				Ski Run				HY89+Boxes				Ski Run				On-site				Snow Yard
38-F	QC Type	QC-T	-				N/A				N/A				N/A				N/A				N/A				N/A
38-F	QC Reference (dup of sample)	QC-R	-				N/A				N/A				N/A				N/A				N/A				N/A
38-F	Unit (Sed., Filter, Mechanized, etc.)	Unit					Filter				Filter				Filter				Filter				Filter				Filter
38-F	Chemical	Chem.	-				None				None				None				None				None				None
38-F	Chemical Dose	Chem. Dose	mg/L				None				None				None				None				None				None
38-F	Sedimentation Time	Sed. Time	hours				24				24				24				24				24				24
38-F	Filter Media	Media	-				Limestone				Limestone				Limestone				Limestone				Limestone				Limestone
38-F	Filter Loading (6 hour or "fast")	Loading	-				6 hr.				6 hr.				6 hr.				6 hr.				6 hr.				6 hr.
38-F	Filter Outlet (free or submerged)	Filt. Outlet	-				Sub.				Sub.				Sub.				Sub.				Sub.				Sub.
38-F	Pilot Plant ID #	Plant ID#	-				07-38-F				08-38-F				09-38-F				10-38-F				11-38-F				12-38-F
38-F	Laboratory Log #	Lab #	-				T303046-30				T303052-27				T-305008-22				T-305011-19				T-305028-24				T-305040-27
38-F	Alkalinity - total	Alk-T	mg-$CaCO_3$/L				50				45	U	x		69				73				49				68
38-F	Aluminum - acid soluble	Al-AS	µg/L				39				70				33			<	25				110				420
38-F	Aluminum - dissolved	Al-D	µg/L			<	25			<	25			<	25			<	25			<	25				34
38-F	Aluminum - total	Al-T	µg/L				240				450				150				41				2900	J	m		12000
38-F	Ammonia	NH_4	mg-N/L			<	0.1			<	0.1			<	0.1			<	0.1			<	0.1			<	0.1
38-F	Conductivity (field)	EC	µmhos/cm				599				311				486				302				1405				497
38-F	Iron - dissolved	Fe-D	µg/L			<	25			<	25			<	25			<	25			<	25			<	25
38-F	Iron - total	Fe-T	µg/L				210				420				480				86	J	m		2200				10000
38-F	Kjeldahl Nitrogen - dissolved	TKN-D	mg-N/L	UJ	Q,x		0.30	J	Q		0.28	UJ	d,Q,x		0.47	U	x		0.24	U	x		0.12	U	x		0.37
38-F	Kjeldahl Nitrogen - total	TKN-T	mg-N/L	J	Q		0.15	J	Q		0.15	J	Q		0.28	U	x		0.26	U	x		0.18				0.56
38-F	Nitrate Nitrogen	NO_3	mg-N/L			<	0.1			<	0.1				0.12			<	0.1			<	0.1			<	0.1
38-F	Nitrite Nitrogen	NO_2	mg-N/L			<	0.1			<	0.1			<	0.1			<	0.1			<	0.1			<	0.1
38-F	Oil & Grease	O&G	mg/L			<	2			<	2			<	2			<	2			<	2			<	2
38-F	Organic Carbon - total	TOC	mg/L	J	m		20				5				6				4.3				4				29
38-F	Orthophosphate - dissolved	OP-D	mg-P/L			<	0.03			<	0.03			<	0.03			<	0.03			<	0.03			<	0.03
38-F	Orthophosphate - total	OP-T	mg-P/L			<	0.03			<	0.03			<	0.03			<	0.03				0.03				0.13
38-F	pH (field)	pH	pH Units				8.0				8.9				8.0				8.3				8.2				8.5
38-F	Phosphorus - dissolved	Phos-D	mg-P/L			<	0.03			<	0.03			<	0.03				0.06			<	0.03			<	0.03
38-F	Phosphorus - total	Phos-T	mg-P/L			<	0.03				0.03				0.06				0.05				0.14				0.40
38-F	Temperature (field)	Temp	°C				4.0				6.2				7.7				7.8				13.6				17.4
38-F	Total Dissolved Solids	TDS	mg/L				312				182				284				192	U	x		842				364
38-F	Total Nitrogen (calculated)	TN	mg-N/L				0.15				0.15				0.40				0.26				0.18				0.56
38-F	Total Suspended Solids	TSS	mg/L	U	x		2			<	1				8			<	1				20				32
38-F	Turbidity (field)	Turb	NTU				8.5				15.8				11.8				3.5				55.4				263

Caltrans Lake Tahoe Small-Scale Storm Water Treatment Pilot Plant

Phase II Water Quality Data, 2003

Treatment Designation	PARAMETER	ABV.	UNITS	Run 7	Run 8	Run 9	Run 10	Run 11	Run 12
				Data Qualifier Reason = Result	Data Qualifier Reason = Result	Data Qualifier Reason = Result	Data Qualifier Reason = Result	Data Qualifier Reason = Result	Data Qualifier Reason = Result
39-S	Run #	Run #	-	7	8	9	10	11	12
39-S	Date of Collection	Date - Col	-	3/15/2003	3/15/2003	5/6/2003	5/6/2003	5/20/2003	5/27/2003
39-S	Date Run (Day 1)	Date - Run		3/16/2003	3/18/2003	5/6/2003	5/8/2003	5/20/2003	5/27/2003
39-S	Lab Name	Lab	-	Soil/Tox	Soil/Tox	Soil/Tox	Soil/Tox	Soil/Tox	Soil/Tox
39-S	Water Source	Source	-	HY89+Boxes	Ski Run	HY89+Boxes	Ski Run	On-site	Snow Yard
39-S	QC Type	QC-T	-	N/A	N/A	N/A	N/A	N/A	N/A
39-S	QC Reference (dup of sample)	QC-R	-	N/A	N/A	N/A	N/A	N/A	N/A
39-S	Unit (Sed., Filter, Mechanized, etc.)	Unit		Sed.	Sed.	Sed.	Sed.	Sed.	Sed.
39-S	Chemical	Chem.	-	None	None	None	None	None	None
39-S	Chemical Dose	Chem. Dose	mg/L	None	None	None	None	None	None
39-S	Sedimentation Time	Sed. Time	hours	24	24	24	24	24	24
39-S	Filter Media	Media	-	N/A	N/A	N/A	N/A	N/A	N/A
39-S	Filter Loading (6 hour or "fast")	Loading	-	N/A	N/A	N/A	N/A	N/A	N/A
39-S	Filter Outlet (free or submerged)	Filt. Outlet	-	N/A	N/A	N/A	N/A	N/A	N/A
39-S	Pilot Plant ID #	Plant ID#	-	Not Run	Not Run	Not Run	Not Run	Not Sampled	Not Sampled
39-S	Laboratory Log #	Lab #	-	(no media)	(no media)	(no media)	(no media)		
39-S	Alkalinity - total	Alk-T	mg-$CaCO_3$/L						
39-S	Aluminum - acid soluble	Al-AS	µg/L						
39-S	Aluminum - dissolved	Al-D	µg/L						
39-S	Aluminum - total	Al-T	µg/L						
39-S	Ammonia	NH_4	mg-N/L						
39-S	Conductivity (field)	EC	µmhos/cm						
39-S	Iron - dissolved	Fe-D	µg/L						
39-S	Iron - total	Fe-T	µg/L						
39-S	Kjeldahl Nitrogen - dissolved	TKN-D	mg-N/L						
39-S	Kjeldahl Nitrogen - total	TKN-T	mg-N/L						
39-S	Nitrate Nitrogen	NO_3	mg-N/L						
39-S	Nitrite Nitrogen	NO_2	mg-N/L						
39-S	Oil & Grease	O&G	mg/L						
39-S	Organic Carbon - total	TOC	mg/L						
39-S	Orthophosphate - dissolved	OP-D	mg-P/L						
39-S	Orthophosphate - total	OP-T	mg-P/L						
39-S	pH (field)	pH	pH Units						
39-S	Phosphorus - dissolved	Phos-D	mg-P/L						
39-S	Phosphorus - total	Phos-T	mg-P/L						
39-S	Temperature (field)	Temp	°C						
39-S	Total Dissolved Solids	TDS	mg/L						
39-S	Total Nitrogen (calculated)	TN	mg-N/L						
39-S	Total Suspended Solids	TSS	mg/L						
39-S	Turbidity (field)	Turb	NTU						

Caltrans Lake Tahoe Small-Scale Storm Water Treatment Pilot Plant

Phase II Water Quality Data, 2003

Treatment Designation	PARAMETER	ABV.	UNITS	Run 7			Run 8			Run 9			Run 10			Run 11			Run 12		
				Data Qualifier	Reason	Result =	Data Qualifier	Reason	Result =	Data Qualifier	Reason	Result =	Data Qualifier	Reason	Result =	Data Qualifier	Reason	Result =	Data Qualifier	Reason	Result =
39-F	Run #	Run #	-			7			8			9			10			11			12
39-F	Date of Collection	Date - Col	-			3/15/2003			3/15/2003			5/6/2003			5/6/2003			5/20/2003			5/27/2003
39-F	Date Run (Day 1)	Date - Run				3/16/2003			3/18/2003			5/6/2003			5/8/2003			5/20/2003			5/27/2003
39-F	Lab Name	Lab	-			Soil/Tox			Soil/Tox			Soil/Tox			Soil/Tox			Soil/Tox			Soil/Tox
39-F	Water Source	Source	-			HY89+Boxes			Ski Run			HY89+Boxes			Ski Run			On-site			Snow Yard
39-F	QC Type	QC-T	-			N/A			N/A			N/A			N/A			N/A			N/A
39-F	QC Reference (dup of sample)	QC-R	-			N/A			N/A			N/A			N/A			N/A			N/A
39-F	Unit (Sed., Filter, Mechanized, etc.)	Unit				Filter			Filter			Filter			Filter			Filter			Filter
39-F	Chemical	Chem.	-			None			None			None			None			None			None
39-F	Chemical Dose	Chem. Dose	mg/L			None			None			None			None			None			None
39-F	Sedimentation Time	Sed. Time	hours			24			24			24			24			24			24
39-F	Filter Media	Media	-			Wollastonite			Wollastonite			Wollastonite			Wollastonite			Wollastonite			Wollastonite
39-F	Filter Loading (6 hour or "fast")	Loading	-			6 hr.			6 hr.			6 hr.			6 hr.			6 hr.			6 hr.
39-F	Filter Outlet (free or submerged)	Filt. Outlet	-			Sub.			Sub.			Sub.			Sub.			Sub.			Sub.
39-F	Pilot Plant ID #	Plant ID#	-			Not Run			Not Run			Not Run			Not Run			11-39-F			12-39-F
39-F	Laboratory Log #	Lab #	-			(no media)			(no media)			(no media)			(no media)			T-305028-26			T-305040-29
39-F	Alkalinity - total	Alk-T	mg-$CaCO_3$/L															50			57
39-F	Aluminum - acid soluble	Al-AS	µg/L															65			500
39-F	Aluminum - dissolved	Al-D	µg/L															< 25			56
39-F	Aluminum - total	Al-T	µg/L															610			15000
39-F	Ammonia	NH_4	mg-N/L															0.14			< 0.1
39-F	Conductivity (field)	EC	µmhos/cm															1304			390
39-F	Iron - dissolved	Fe-D	µg/L															< 25			< 25
39-F	Iron - total	Fe-T	µg/L													J	m	3800			12000
39-F	Kjeldahl Nitrogen - dissolved	TKN-D	mg-N/L													U	x	0.16	U	x	0.35
39-F	Kjeldahl Nitrogen - total	TKN-T	mg-N/L													U	x	0.20	U	x	0.55
39-F	Nitrate Nitrogen	NO_3	mg-N/L															< 0.1			< 0.1
39-F	Nitrite Nitrogen	NO_2	mg-N/L															< 0.1			< 0.1
39-F	Oil & Grease	O&G	mg/L															< 2			< 2
39-F	Organic Carbon - total	TOC	mg/L															5			15
39-F	Orthophosphate - dissolved	OP-D	mg-P/L															< 0.03			< 0.03
39-F	Orthophosphate - total	OP-T	mg-P/L															0.06			0.15
39-F	pH (field)	pH	pH Units															9.1			9.1
39-F	Phosphorus - dissolved	Phos-D	mg-P/L															0.08			0.05
39-F	Phosphorus - total	Phos-T	mg-P/L															0.20			0.47
39-F	Temperature (field)	Temp	°C															14.1			16.5
39-F	Total Dissolved Solids	TDS	mg/L													U	x	750			336
39-F	Total Nitrogen (calculated)	TN	mg-N/L															0.20			0.55
39-F	Total Suspended Solids	TSS	mg/L															26			36
39-F	Turbidity (field)	Turb	NTU															90.4			315

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Phase II Water Quality Data, 2003

Treatment Designation	PARAMETER	ABV.	UNITS	Run 7		Run 8		Run 9		Run 10		Run 11		Run 12	
				Data Qualifier	Result Reason =	Data Qualifier	Result Reason =	Data Qualifier	Result Reason =	Data Qualifier	Result Reason =	Data Qualifier	Result Reason =	Data Qualifier	Result Reason =
40-S	Run #	Run #	-		7		8		9		10		11		12
40-S	Date of Collection	Date - Col	-		3/15/2003		3/15/2003		5/6/2003		5/6/2003		5/20/2003		5/27/2003
40-S	Date Run (Day 1)	Date - Run			3/16/2003		3/18/2003		5/6/2003		5/8/2003		5/20/2003		5/27/2003
40-S	Lab Name	Lab	-		Soil/Tox		Soil/Tox		Soil/Tox		Soil/Tox		Soil/Tox		Soil/Tox
40-S	Water Source	Source	-		HY89+Boxes		Ski Run		HY89+Boxes		Ski Run		On-site		Snow Yard
40-S	QC Type	QC-T	-		N/A		N/A		N/A		N/A		N/A		N/A
40-S	QC Reference (dup of sample)	QC-R	-		N/A		N/A		N/A		N/A		N/A		N/A
40-S	Unit (Sed., Filter, Mechanized, etc.)	Unit			Sed.		Sed.		Sed.		Sed.		Sed.		Sed.
40-S	Chemical	Chem.	-		None		None		None		None		None		None
40-S	Chemical Dose	Chem. Dose	mg/L		None		None		None		None		None		None
40-S	Sedimentation Time	Sed. Time	hours		24		24		24		24		24		24
40-S	Filter Media	Media	-		N/A		N/A		N/A		N/A		N/A		N/A
40-S	Filter Loading (6 hour or "fast")	Loading	-		N/A		N/A		N/A		N/A		N/A		N/A
40-S	Filter Outlet (free or submerged)	Filt. Outlet	-		N/A		N/A		N/A		N/A		N/A		N/A
40-S	Pilot Plant ID #	Plant ID#	-		Not Sampled		Not Sampled		Not Sampled		Not Sampled		Not Sampled		Not Sampled
40-S	Laboratory Log #	Lab #	-												
40-S	Alkalinity - total	Alk-T	mg-$CaCO_3$/L												
40-S	Aluminum - acid soluble	Al-AS	µg/L												
40-S	Aluminum - dissolved	Al-D	µg/L												
40-S	Aluminum - total	Al-T	µg/L												
40-S	Ammonia	NH_4	mg-N/L												
40-S	Conductivity (field)	EC	µmhos/cm												
40-S	Iron - dissolved	Fe-D	µg/L												
40-S	Iron - total	Fe-T	µg/L												
40-S	Kjeldahl Nitrogen - dissolved	TKN-D	mg-N/L												
40-S	Kjeldahl Nitrogen - total	TKN-T	mg-N/L												
40-S	Nitrate Nitrogen	NO_3	mg-N/L												
40-S	Nitrite Nitrogen	NO_2	mg-N/L												
40-S	Oil & Grease	O&G	mg/L												
40-S	Organic Carbon - total	TOC	mg/L												
40-S	Orthophosphate - dissolved	OP-D	mg-P/L												
40-S	Orthophosphate - total	OP-T	mg-P/L												
40-S	pH (field)	pH	pH Units												
40-S	Phosphorus - dissolved	Phos-D	mg-P/L												
40-S	Phosphorus - total	Phos-T	mg-P/L												
40-S	Temperature (field)	Temp	°C												
40-S	Total Dissolved Solids	TDS	mg/L												
40-S	Total Nitrogen (calculated)	TN	mg-N/L												
40-S	Total Suspended Solids	TSS	mg/L												
40-S	Turbidity (field)	Turb	NTU												

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Treatment Designation	PARAMETER	ABV.	UNITS	Run 7				Run 8				Run 9				Run 10				Run 11				Run 12			
				Data Qualifier	Reason	=	Result	Data Qualifier	Reason	=	Result	Data Qualifier	Reason	=	Result	Data Qualifier	Reason	=	Result	Data Qualifier	Reason	=	Result	Data Qualifier	Reason	=	Result
40-F	Run #	Run #	-				7				8				9				10				11				12
40-F	Date of Collection	Date - Col	-				3/15/2003				3/15/2003				5/6/2003				5/6/2003				5/20/2003				5/27/2003
40-F	Date Run (Day 1)	Date - Run					3/16/2003				3/18/2003				5/6/2003				5/8/2003				5/20/2003				5/27/2003
40-F	Lab Name	Lab	-				Soil/Tox				Soil/Tox				Soil/Tox				Soil/Tox				Soil/Tox				Soil/Tox
40-F	Water Source	Source	-				HY89+Boxes				Ski Run				HY89+Boxes				Ski Run				On-site				Snow Yard
40-F	QC Type	QC-T	-				N/A				N/A				N/A				N/A				N/A				N/A
40-F	QC Reference (dup of sample)	QC-R	-				N/A				N/A				N/A				N/A				N/A				N/A
40-F	Unit (Sed., Filter, Mechanized, etc.)	Unit					Filter				Filter				Filter				Filter				Filter				Filter
40-F	Chemical	Chem.	-				None				None				None				None				None				None
40-F	Chemical Dose	Chem. Dose	mg/L				None				None				None				None				None				None
40-F	Sedimentation Time	Sed. Time	hours				24				24				24				24				24				24
40-F	Filter Media	Media	-				Act. Alumina				Act. Alumina				Act. Alumina				Act. Alumina				Act. Alumina				Act. Alumina
40-F	Filter Loading (6 hour or "fast")	Loading	-				6 hr.				6 hr.				6 hr.				6 hr.				6 hr.				6 hr.
40-F	Filter Outlet (free or submerged)	Filt. Outlet	-				Sub.				Sub.				Sub.				Sub.				Sub.				Sub.
40-F	Pilot Plant ID #	Plant ID#	-				07-40-F				08-40-F				09-40-F				10-40-F				11-40-F				12-40-F
40-F	Laboratory Log #	Lab #	-				T303046-32				T303052-29				T-305008-24				T-305011-21				T-305028-27				T-305040-30
40-F	Alkalinity - total	Alk-T	mg-$CaCO_3$/L				34				37	U	x		52				50				34				32
40-F	Aluminum - acid soluble	Al-AS	µg/L				588				590				470				490				270				370
40-F	Aluminum - dissolved	Al-D	µg/L				520				560				440				480				280				370
40-F	Aluminum - total	Al-T	µg/L				550				560				460				500				450	J	m		1300
40-F	Ammonia	NH_4	mg-N/L			<	0.1			<	0.1			<	0.1			<	0.1			<	0.1			<	0.1
40-F	Conductivity (field)	EC	µmhos/cm				382				397				317				261				827				799
40-F	Iron - dissolved	Fe-D	µg/L			<	25			<	25			<	25			<	25			<	25			<	25
40-F	Iron - total	Fe-T	µg/L			<	25			<	25			<	25			<	25	J	m		100				910
40-F	Kjeldahl Nitrogen - dissolved	TKN-D	mg-N/L	U	x		0.14	J	Q		0.27	UJ	d,x		0.15	U	x		0.15	U	x		0.11	UJ	Q,x		0.39
40-F	Kjeldahl Nitrogen - total	TKN-T	mg-N/L			<	0.1	UJ	Q	<	0.1				0.15	U	x		0.16			<	0.1	UJ	Q,x		0.19
40-F	Nitrate Nitrogen	NO_3	mg-N/L				0.11			<	0.1			<	0.1			<	0.11			<	0.1			<	0.1
40-F	Nitrite Nitrogen	NO_2	mg-N/L			<	0.1			<	0.1			<	0.1			<	0.1			<	0.1			<	0.1
40-F	Oil & Grease	O&G	mg/L			<	2			<	2			<	2			<	2			<	2			<	2
40-F	Organic Carbon - total	TOC	mg/L	J	m		10				2				2				1.9			<	1			<	1
40-F	Orthophosphate - dissolved	OP-D	mg-P/L			<	0.03			<	0.03			<	0.03			<	0.03			<	0.03			<	0.03
40-F	Orthophosphate - total	OP-T	mg-P/L			<	0.03			<	0.03			<	0.03			<	0.03			<	0.03			<	0.03
40-F	pH (field)	pH	pH Units				8.8				8.9				9.2				9.5				9.0				8.8
40-F	Phosphorus - dissolved	Phos-D	mg-P/L			<	0.03			<	0.03			<	0.03			<	0.03			<	0.03			<	0.03
40-F	Phosphorus - total	Phos-T	mg-P/L			<	0.03			<	0.03			<	0.03			<	0.03			<	0.03				0.04
40-F	Temperature (field)	Temp	°C				4.0				5.9				7.3				7.7				14.0				17.5
40-F	Total Dissolved Solids	TDS	mg/L				198				186				160				144	U	x		392				396
40-F	Total Nitrogen (calculated)	TN	mg-N/L				0.11			<	0.1				0.15				0.27			<	0.1				0.19
40-F	Total Suspended Solids	TSS	mg/L			<	1			<	1			<	1			<	1	U	x		6			<	1
40-F	Turbidity (field)	Turb	NTU				0.3				0.1				0.13				0.07				2.6				23.8

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Treatment Designation	PARAMETER	ABV.	UNITS	Run 7				Run 8				Run 9				Run 10				Run 11				Run 12			
				Data Qualifier	Reason	=	Result	Data Qualifier	Reason	=	Result	Data Qualifier	Reason	=	Result	Data Qualifier	Reason	=	Result	Data Qualifier	Reason	=	Result	Data Qualifier	Reason	=	Result
PA	Run #	Run #	-				7				8				9				10				11				12
PA	Date of Collection	Date - Col	-				3/15/2003				3/15/2003				5/6/2003				5/6/2003				5/20/2003				5/27/2003
PA	Date Run (Day 1)	Date - Run					3/16/2003				3/18/2003				5/6/2003				5/8/2003				5/20/2003				5/27/2003
PA	Lab Name	Lab	-				Soil/Tox				Soil/Tox				Soil/Tox				Soil/Tox				Soil/Tox				Soil/Tox
PA	Water Source	Source	-				HY89+Boxes				Ski Run				HY89+Boxes				Ski Run				On-site				Snow Yard
PA	QC Type	QC-T	-				N/A				N/A				N/A				N/A				N/A				N/A
PA	QC Reference (dup of sample)	QC-R	-				N/A				N/A				N/A				N/A				N/A				N/A
PA	Unit (Sed., Filter, Mechanized, etc.)	Unit					Actiflo(R)				Actiflo(R)				Actiflo(R)				Actiflo(R)				Actiflo(R)				Actiflo(R)
PA	Chemical	Chem.	-				Coag+Poly+S				Coag+Poly+S				Coag+Poly+S				Coag+Poly+S				Coag+Poly+S				Coag+Poly+S
PA	Chemical Dose	Chem. Dose	mg/L				75 (Pass C)				75 (Pass C)				170 (Pass C)				200 (Pass C)				100 (Pass C)				120 (Pass C)
PA	Sedimentation Time	Sed. Time	hours				0.13 (8 min)				0.13 (8 min)				0.13 (8 min)				0.13 (8 min)				0.13 (8 min)				0.13 (8 min)
PA	Filter Media	Media	-				N/A				N/A				N/A				N/A				N/A				N/A
PA	Filter Loading (6 hour or "fast")	Loading	-				N/A				N/A				N/A				N/A				N/A				N/A
PA	Filter Outlet (free or submerged)	Filt. Outlet	-				N/A				N/A				N/A				N/A				N/A				N/A
PA	Pilot Plant ID #	Plant ID#	-				07-PA				08-PA				09-PA				10-PA				11-PA				12-PA
PA	Laboratory Log #	Lab #	-				T303046-18				T303052-20				T-305008-16				T-305011-30				T-305028-16				T-305040-16
PA	Alkalinity - total	Alk-T	mg-$CaCO_3$/L				22				21	U	x		21				40				15				18
PA	Aluminum - acid soluble	Al-AS	µg/L				69				69				360				110			<	25				47
PA	Aluminum - dissolved	Al-D	µg/L				39	U	x		25			<	25			<	25			<	25	J	f		94
PA	Aluminum - total	Al-T	µg/L				230				160				460	U	x		140				130	J	m		110
PA	Ammonia	NH_4	mg-N/L			<	0.1			<	0.1				0.13			<	0.1			<	0.1			<	0.1
PA	Conductivity (field)	EC	µmhos/cm				604				279				325				327				1350				298
PA	Iron - dissolved	Fe-D	µg/L			<	25			<	25			<	25			<	25			<	25			<	25
PA	Iron - total	Fe-T	µg/L				160				58				65			<	25				120				97
PA	Kjeldahl Nitrogen - dissolved	TKN-D	mg-N/L	U	x		0.25				0.16	U	x		0.24	U	x		0.27	U	x		0.24	UJ	Q,x		0.45
PA	Kjeldahl Nitrogen - total	TKN-T	mg-N/L				0.27				0.25	J	d		0.30	U	x		0.20	U	x		0.17	UJ	Q,x		0.27
PA	Nitrate Nitrogen	NO_3	mg-N/L			<	0.1			<	0.1			<	0.1	UJ	h	<	0.1			<	0.1			<	0.1
PA	Nitrite Nitrogen	NO_2	mg-N/L			<	0.1			<	0.1			<	0.1	UJ	h	<	0.1			<	0.1			<	0.1
PA	Oil & Grease	O&G	mg/L			<	2			<	2			<	2	UJ	h	<	2			<	2			<	2
PA	Organic Carbon - total	TOC	mg/L				5				5				6				2.5				1				2
PA	Orthophosphate - dissolved	OP-D	mg-P/L			<	0.03			<	0.03			<	0.03	UJ	h	<	0.03			<	0.03			<	0.03
PA	Orthophosphate - total	OP-T	mg-P/L			<	0.03			<	0.03			<	0.03	UJ	h	<	0.03			<	0.03			<	0.03
PA	pH (field)	pH	pH Units				7.0				6.5				6.5				6.8				6.8				6.6
PA	Phosphorus - dissolved	Phos-D	mg-P/L			<	0.03			<	0.03			<	0.03				0.03			<	0.03			<	0.03
PA	Phosphorus - total	Phos-T	mg-P/L			<	0.03			<	0.03			<	0.03				0.03			<	0.03			<	0.03
PA	Temperature (field)	Temp	°C				5.2				6.1				9.0				8.1				14.6				14.6
PA	Total Dissolved Solids	TDS	mg/L				304				150				156				194	U	x		728				142
PA	Total Nitrogen (calculated)	TN	mg-N/L				0.27				0.25				0.30				0.20				0.17				0.27
PA	Total Suspended Solids	TSS	mg/L	U	x		10	U	x		2				6			<	1	U	x		4			<	1
PA	Turbidity (field)	Turb	NTU				3.5				2.6				1.9				0.32				1.8				3.2

Caltrans Lake Tahoe Small-Scale Storm Water Treatment Pilot Plant

Phase II Water Quality Data, 2003

Treatment Designation	PARAMETER	ABV.	UNITS	Run 7				Run 8				Run 9				Run 10				Run 11				Run 12			
				Data Qualifier	Reason	=	Result	Data Qualifier	Reason	=	Result	Data Qualifier	Reason	=	Result	Data Qualifier	Reason	=	Result	Data Qualifier	Reason	=	Result	Data Qualifier	Reason	=	Result
PFF	Run #	Run #	-				7				8				9				10				11				12
PFF	Date of Collection	Date - Col	-				3/15/2003				3/15/2003				5/6/2003				5/6/2003				5/20/2003				5/27/2003
PFF	Date Run (Day 1)	Date - Run					3/16/2003				3/18/2003				5/6/2003				5/8/2003				5/20/2003				5/27/2003
PFF	Lab Name	Lab	-				Soil/Tox				Soil/Tox				Soil/Tox				Soil/Tox				Soil/Tox				Soil/Tox
PFF	Water Source	Source	-				HY89+Boxes				Ski Run				HY89+Boxes				Ski Run				On-site				Snow Yard
PFF	QC Type	QC-T	-				N/A				N/A				N/A				N/A				N/A				N/A
PFF	QC Reference (dup of sample)	QC-R	-				N/A				N/A				N/A				N/A				N/A				N/A
PFF	Unit (Sed., Filter, Mechanized, etc.)	Unit					Fuzzy Filt(TM)				Fuzzy Filt(TM)				Fuzzy Filt(TM)				Fuzzy Filt(TM)				Fuzzy Filt(TM)				Fuzzy Filt(TM)
PFF	Chemical	Chem.	-				None				None				None				None				None				None
PFF	Chemical Dose	Chem. Dose	mg/L				None				None				None				None				None				None
PFF	Sedimentation Time	Sed. Time	hours				N/A				N/A				N/A				N/A				N/A				N/A
PFF	Filter Media	Media	-				Synthetic				Synthetic				Synthetic				Synthetic				Synthetic				Synthetic
PFF	Filter Loading (6 hour or "fast")	Loading	-				2.6 gpm				2.6 gpm				2.6 gpm				2.6 gpm				2.6 gpm				2.6 gpm
PFF	Filter Outlet (free or submerged)	Filt. Outlet	-				N/A				N/A				N/A				N/A				N/A				N/A
PFF	Pilot Plant ID #	Plant ID#	-				07-PFF				08-PFF				09-PFF				10-PFF				11-PFF				12-PFF
PFF	Laboratory Log #	Lab #	-				T303046-14				T303052-18				T-305008-13				T-305011-32				T-305028-18				T-305040-20
PFF	Alkalinity - total	Alk-T	mg-$CaCO_3$/L				23				22	U	x		20				39				15				18
PFF	Aluminum - acid soluble	Al-AS	µg/L				46				45			<	25			<	25			<	25	R	Q		190
PFF	Aluminum - dissolved	Al-D	µg/L			<	25			<	25			<	25			<	25			<	25				58
PFF	Aluminum - total	Al-T	µg/L				41				54				83			<	25				35	R	Q		82
PFF	Ammonia	NH_4	mg-N/L			<	0.1			<	0.1				0.13			<	0.1			<	0.1			<	0.1
PFF	Conductivity (field)	EC	µmhos/cm				611				275				327				323				1431				302
PFF	Iron - dissolved	Fe-D	µg/L			<	25			<	25	R	Q		120			<	25			<	25			<	25
PFF	Iron - total	Fe-T	µg/L			<	25			<	25	R	Q	<	25			<	25	J	m		29				53
PFF	Kjeldahl Nitrogen - dissolved	TKN-D	mg-N/L	U	x		0.25				0.15	UJ	Q,x		0.50	U	x		0.26	U	x		0.21	UJ	Q,x		0.37
PFF	Kjeldahl Nitrogen - total	TKN-T	mg-N/L				0.26				0.23	J	d,Q		0.23	U	x		0.21	U	x		0.21	UJ	Q,x		0.20
PFF	Nitrate Nitrogen	NO_3	mg-N/L				0.11			<	0.1			<	0.1	J	h		0.24			<	0.1			<	0.1
PFF	Nitrite Nitrogen	NO_2	mg-N/L			<	0.1			<	0.1			<	0.1	UJ	h	<	0.1			<	0.1			<	0.1
PFF	Oil & Grease	O&G	mg/L			<	2			<	2			<	2	UJ	h	<	2			<	2			<	2
PFF	Organic Carbon - total	TOC	mg/L				6				5				5				2.4				1				2
PFF	Orthophosphate - dissolved	OP-D	mg-P/L			<	0.03			<	0.03			<	0.03	UJ	h	<	0.03			<	0.03			<	0.03
PFF	Orthophosphate - total	OP-T	mg-P/L			<	0.03			<	0.03			<	0.03	UJ	h	<	0.03			<	0.03			<	0.03
PFF	pH (field)	pH	pH Units				7.2				6.7				6.5				6.9				6.7				6.6
PFF	Phosphorus - dissolved	Phos-D	mg-P/L			<	0.03			<	0.03			<	0.03				0.05			<	0.03			<	0.03
PFF	Phosphorus - total	Phos-T	mg-P/L			<	0.03			<	0.03			<	0.03				0.07			<	0.03			<	0.03
PFF	Temperature (field)	Temp	°C				5.0				5.8				8.4				8.1				10.9				14.6
PFF	Total Dissolved Solids	TDS	mg/L				304				170				156				200	U	x		714				112
PFF	Total Nitrogen (calculated)	TN	mg-N/L				0.37				0.23				0.23				0.45				0.21				0.20
PFF	Total Suspended Solids	TSS	mg/L	J	f	<	1			<	1			<	1			<	1	UJ	f,x		4			<	1
PFF	Turbidity (field)	Turb	NTU				0.8				0.5				0.35				0.27				0.85				1.9

Caltrans Lake Tahoe Small-Scale Storm Water Treatment Pilot Plant

Phase II Water Quality Data, 2003

Treatment Designation	PARAMETER	ABV.	UNITS	Run 7		Run 8		Run 9		Run 10		Run 11		Run 12	
				Data Qualifier	Result Reason =	Data Qualifier	Result Reason =	Data Qualifier	Result Reason =	Data Qualifier	Result Reason =	Data Qualifier	Result Reason =	Data Qualifier	Result Reason =
PC	Run #	Run #	-		7		8		9		10		11		12
PC	Date of Collection	Date - Col	-		3/15/2003		3/15/2003		5/6/2003		5/6/2003		5/20/2003		5/27/2003
PC	Date Run (Day 1)	Date - Run			3/16/2003		3/18/2003		5/6/2003		5/8/2003		5/20/2003		5/27/2003
PC	Lab Name	Lab	-		Soil/Tox		Soil/Tox		Soil/Tox		Soil/Tox		Soil/Tox		Soil/Tox
PC	Water Source	Source	-		HY89+Boxes		Ski Run		HY89+Boxes		Ski Run		On-site		Snow Yard
PC	QC Type	QC-T	-		N/A		N/A		N/A		N/A		N/A		N/A
PC	QC Reference (dup of sample)	QC-R	-		N/A		N/A		N/A		N/A		N/A		N/A
PC	Unit (Sed., Filter, Mechanized, etc.)	Unit			Cation		Cation		Cation		Cation		Cation		Cation
PC	Chemical	Chem.	-		None		None		None		None		None		None
PC	Chemical Dose	Chem. Dose	mg/L		None		None		None		None		None		None
PC	Sedimentation Time	Sed. Time	hours		N/A		N/A		N/A		N/A		N/A		N/A
PC	Filter Media	Media	-		IX Resin		IX Resin		IX Resin		IX Resin		IX Resin		IX Resin
PC	Filter Loading (6 hour or "fast")	Loading	-		2.6 gpm		2.6 gpm		2.6 gpm		2.6 gpm		2.6 gpm		2.6 gpm
PC	Filter Outlet (free or submerged)	Filt. Outlet	-		N/A		N/A		N/A		N/A		N/A		N/A
PC	Pilot Plant ID #	Plant ID#	-		Not Sampled		Not Sampled		Not Sampled		Not Sampled		Not Sampled		Not Sampled
PC	Laboratory Log #	Lab #	-												
PC	Alkalinity - total	Alk-T	mg-$CaCO_3$/L												
PC	Aluminum - acid soluble	Al-AS	µg/L												
PC	Aluminum - dissolved	Al-D	µg/L												
PC	Aluminum - total	Al-T	µg/L												
PC	Ammonia	NH_4	mg-N/L												
PC	Conductivity (field)	EC	µmhos/cm												
PC	Iron - dissolved	Fe-D	µg/L												
PC	Iron - total	Fe-T	µg/L												
PC	Kjeldahl Nitrogen - dissolved	TKN-D	mg-N/L												
PC	Kjeldahl Nitrogen - total	TKN-T	mg-N/L												
PC	Nitrate Nitrogen	NO_3	mg-N/L												
PC	Nitrite Nitrogen	NO_2	mg-N/L												
PC	Oil & Grease	O&G	mg/L												
PC	Organic Carbon - total	TOC	mg/L												
PC	Orthophosphate - dissolved	OP-D	mg-P/L												
PC	Orthophosphate - total	OP-T	mg-P/L												
PC	pH (field)	pH	pH Units												
PC	Phosphorus - dissolved	Phos-D	mg-P/L												
PC	Phosphorus - total	Phos-T	mg-P/L												
PC	Temperature (field)	Temp	°C												
PC	Total Dissolved Solids	TDS	mg/L												
PC	Total Nitrogen (calculated)	TN	mg-N/L												
PC	Total Suspended Solids	TSS	mg/L												
PC	Turbidity (field)	Turb	NTU												

Caltrans Lake Tahoe Small-Scale Storm Water Treatment Pilot Plant

Phase II Water Quality Data, 2003

Treatment Designation	PARAMETER	ABV.	UNITS	Run 7				Run 8				Run 9				Run 10				Run 11				Run 12			
				Data Qualifier	Reason	=	Result	Data Qualifier	Reason	=	Result	Data Qualifier	Reason	=	Result	Data Qualifier	Reason	=	Result	Data Qualifier	Reason	=	Result	Data Qualifier	Reason	=	Result
PCA	Run #	Run #	-				7				8				9				10				11				12
PCA	Date of Collection	Date - Col	-				3/15/2003				3/15/2003				5/6/2003				5/6/2003				5/20/2003				5/27/2003
PCA	Date Run (Day 1)	Date - Run					3/16/2003				3/18/2003				5/6/2003				5/8/2003				5/20/2003				5/27/2003
PCA	Lab Name	Lab	-				Soil/Tox				Soil/Tox				Soil/Tox				Soil/Tox				Soil/Tox				Soil/Tox
PCA	Water Source	Source	-				HY89+Boxes				Ski Run				HY89+Boxes				Ski Run				On-site				Snow Yard
PCA	QC Type	QC-T	-				N/A				N/A				N/A				N/A				N/A				N/A
PCA	QC Reference (dup of sample)	QC-R	-				N/A				N/A				N/A				N/A				N/A				N/A
PCA	Unit (Sed., Filter, Mechanized, etc.)	Unit					Anion				Anion				Anion				Anion				Anion				Anion
PCA	Chemical	Chem.	-				None				None				None				None				None				None
PCA	Chemical Dose	Chem. Dose	mg/L				None				None				None				None				None				None
PCA	Sedimentation Time	Sed. Time	hours				N/A				N/A				N/A				N/A				N/A				N/A
PCA	Filter Media	Media	-				IX Resin				IX Resin				IX Resin				IX Resin				IX Resin				IX Resin
PCA	Filter Loading (6 hour or "fast")	Loading	-				2.6 gpm				2.6 gpm				2.6 gpm				2.6 gpm				2.6 gpm				2.6 gpm
PCA	Filter Outlet (free or submerged)	Filt. Outlet	-				N/A				N/A				N/A				N/A				N/A				N/A
PCA	Pilot Plant ID #	Plant ID#	-				07-PCA				08-PCA				09-PCA				10-PCA				11-PCA				12-PCA
PCA	Laboratory Log #	Lab #	-				T303046-13				T303052-19				T-305008-14				T-305011-31				T-305028-17				T-305040-19
PCA	Alkalinity - total	Alk-T	mg-$CaCO_3$/L				23				14	U	x		7.2				12				18	U	x		13
PCA	Aluminum - acid soluble	Al-AS	µg/L				28				28			<	25			<	25			<	25			<	25
PCA	Aluminum - dissolved	Al-D	µg/L				31			<	25			<	25			<	25			<	25				43
PCA	Aluminum - total	Al-T	µg/L			<	25				36			<	25	U	x		43				27	UJ	m		47
PCA	Ammonia	NH_4	mg-N/L			<	0.1			<	0.1			<	0.1			<	0.1			<	0.1			<	0.1
PCA	Conductivity (field)	EC	µmhos/cm				600				294				342				349				1427				300
PCA	Iron - dissolved	Fe-D	µg/L			<	25			<	25			<	25			<	25			<	25			<	25
PCA	Iron - total	Fe-T	µg/L			<	25			<	25			<	25			<	25	UJ	m	<	25				32
PCA	Kjeldahl Nitrogen - dissolved	TKN-D	mg-N/L	U	x		0.17				0.12	U	x		0.25	U	x		0.14	U	x		0.22	UJ	Q,x		0.29
PCA	Kjeldahl Nitrogen - total	TKN-T	mg-N/L				0.18				0.18	J	d		0.15	U	x		0.14	U	x		0.22	UJ	Q,x		0.18
PCA	Nitrate Nitrogen	NO_3	mg-N/L			<	0.1			<	0.1			<	0.1	UJ	h	<	0.1			<	0.1			<	0.1
PCA	Nitrite Nitrogen	NO_2	mg-N/L			<	0.1			<	0.1			<	0.1	UJ	h	<	0.1			<	0.1			<	0.1
PCA	Oil & Grease	O&G	mg/L			<	2			<	2			<	2	UJ	h	<	2			<	2			<	2
PCA	Organic Carbon - total	TOC	mg/L				3				2				3				1.1			<	1			<	1
PCA	Orthophosphate - dissolved	OP-D	mg-P/L			<	0.03			<	0.03			<	0.03	UJ	h	<	0.03			<	0.03			<	0.03
PCA	Orthophosphate - total	OP-T	mg-P/L			<	0.03			<	0.03			<	0.03	UJ	h	<	0.03			<	0.03			<	0.03
PCA	pH (field)	pH	pH Units				7.2				6.6				6.0				6.3				6.7				6.5
PCA	Phosphorus - dissolved	Phos-D	mg-P/L			<	0.03			<	0.03			<	0.03				0.04			<	0.03			<	0.03
PCA	Phosphorus - total	Phos-T	mg-P/L			<	0.03			<	0.03			<	0.03				0.07			<	0.03			<	0.03
PCA	Temperature (field)	Temp	°C				5.3				6.2				8.6				8.3				10.1				13.9
PCA	Total Dissolved Solids	TDS	mg/L				290				152				150				190	U	x		718				132
PCA	Total Nitrogen (calculated)	TN	mg-N/L				0.18				0.18				0.15				0.14				0.22				0.18
PCA	Total Suspended Solids	TSS	mg/L			<	1			<	1			<	1			<	1	U	x		2			<	1
PCA	Turbidity (field)	Turb	NTU				0.2				0.3				0.16				0.11				0.41				0.90

Caltrans Lake Tahoe Small-Scale Storm Water Treatment Pilot Plant

Phase II Water Quality Data, 2003

Treatment Designation	PARAMETER	ABV.	UNITS	Run 7				Run 8				Run 9				Run 10				Run 11				Run 12			
				Data Qualifier	Reason	=	Result	Data Qualifier	Reason	=	Result	Data Qualifier	Reason	=	Result	Data Qualifier	Reason	=	Result	Data Qualifier	Reason	=	Result	Data Qualifier	Reason	=	Result
CFS	Run #	Run #	-				7				8				9				10				11				12
CFS	Date of Collection	Date - Col	-				3/15/2003				3/15/2003				5/6/2003				5/6/2003				5/20/2003				5/27/2003
CFS	Date Run (Day 1)	Date - Run					3/16/2003				3/18/2003				5/6/2003				5/8/2003				5/20/2003				5/27/2003
CFS	Lab Name	Lab	-				Soil/Tox				Soil/Tox				Soil/Tox				Soil/Tox				Soil/Tox				Soil/Tox
CFS	Water Source	Source	-				HY89+Boxes				Ski Run				HY89+Boxes				Ski Run				On-site				Snow Yard
CFS	QC Type	QC-T	-				N/A				N/A				N/A				N/A				N/A				N/A
CFS	QC Reference (dup of sample)	QC-R	-				N/A				N/A				N/A				N/A				N/A				N/A
CFS	Unit (Sed., Filter, Mechanized, etc.)	Unit					Conv. Floc/Sed				Conv. Floc/Sed				Conv. Floc/Sed				Conv. Floc/Sed				Conv. Floc/Sed				Conv. Floc/Sed
CFS	Chemical	Chem.	-				Coag+Poly				Coag+Poly				Coag+Poly				Coag+Poly				Coag+Poly				Coag+Poly
CFS	Chemical Dose	Chem. Dose	mg/L				75 (Pass C)				75 (Pass C)				75 (Pass C)				75 (Pass C)				75 (Pass C)				75 (Pass C)
CFS	Sedimentation Time	Sed. Time	hours				0.5 (30 min)				0.5 (30 min)				0.5 (30 min)				0.5 (30 min)				0.5 (30 min)				0.5 (30 min)
CFS	Filter Media	Media	-				N/A				N/A				N/A				N/A				N/A				N/A
CFS	Filter Loading (6 hour or "fast")	Loading	-				N/A				N/A				N/A				N/A				N/A				N/A
CFS	Filter Outlet (free or submerged)	Filt. Outlet	-				N/A				N/A				N/A				N/A				N/A				N/A
CFS	Pilot Plant ID #	Plant ID#	-				07-CFS				08-CFS				09-CFS				10-CFS				11-CFS				12-CFS
CFS	Laboratory Log #	Lab #	-				T303046-17				T303052-31				T-305008-30				T-305011-26				T-305028-30				T-305040-03
CFS	Alkalinity - total	Alk-T	mg-$CaCO_3$/L				22				20	U	x		21				40				15				18
CFS	Aluminum - acid soluble	Al-AS	µg/L				129				250				490				130			<	25				120
CFS	Aluminum - dissolved	Al-D	µg/L				54			<	25			<	25				27			<	25				80
CFS	Aluminum - total	Al-T	µg/L				400				400				550				160				360	J	m		270
CFS	Ammonia	NH_4	mg-N/L			<	0.1			<	0.1				0.14			<	0.1			<	0.1			<	0.1
CFS	Conductivity (field)	EC	µmhos/cm				602				278				321				322				1421				293
CFS	Iron - dissolved	Fe-D	µg/L			<	25			<	25			<	25			<	25			<	25			<	25
CFS	Iron - total	Fe-T	µg/L				230				150				45			<	25	J	m		290				160
CFS	Kjeldahl Nitrogen - dissolved	TKN-D	mg-N/L	UJ	Q,x		0.57	J	Q		0.34	UJ	d,Q,x		0.40	U	x		0.19	U	x		0.15	UJ	d,x		0.27
CFS	Kjeldahl Nitrogen - total	TKN-T	mg-N/L	J	Q		0.22	J	Q		0.22	J	Q		0.26	U	x		0.19	U	x		0.11	U	x		0.20
CFS	Nitrate Nitrogen	NO_3	mg-N/L				0.11			<	0.1			<	0.1	UJ	h	<	0.1	UJ	h	<	0.1			<	0.1
CFS	Nitrite Nitrogen	NO_2	mg-N/L			<	0.1			<	0.1			<	0.1	UJ	h	<	0.1	UJ	h	<	0.1			<	0.1
CFS	Oil & Grease	O&G	mg/L			<	2			<	2			<	2	UJ	h	<	2			<	2			<	2
CFS	Organic Carbon - total	TOC	mg/L				6				5				6				2.1				1				2
CFS	Orthophosphate - dissolved	OP-D	mg-P/L			<	0.03			<	0.03			<	0.03	UJ	h	<	0.03	UJ	h	<	0.03			<	0.03
CFS	Orthophosphate - total	OP-T	mg-P/L			<	0.03			<	0.03			<	0.03	UJ	h	<	0.03	UJ	h	<	0.03			<	0.03
CFS	pH (field)	pH	pH Units				6.9				6.6				6.4				6.8				6.6				6.5
CFS	Phosphorus - dissolved	Phos-D	mg-P/L			<	0.03			<	0.03			<	0.03				0.05			<	0.03			<	0.03
CFS	Phosphorus - total	Phos-T	mg-P/L			<	0.03			<	0.03			<	0.03			<	0.03			<	0.03				0.03
CFS	Temperature (field)	Temp	°C				5.0				7.3				9.5				8.3				13.6				14.8
CFS	Total Dissolved Solids	TDS	mg/L				296				140				160				226	U	x		714				128
CFS	Total Nitrogen (calculated)	TN	mg-N/L				0.33				0.22				0.26				0.19				0.11				0.20
CFS	Total Suspended Solids	TSS	mg/L	U	x		10	U	x		6				2			<	1				12			<	1
CFS	Turbidity (field)	Turb	NTU				7.0				7.2				0.84				0.21				7.8				8.4

Caltrans Lake Tahoe Small-Scale Storm Water Treatment Pilot Plant

Phase II Water Quality Data, 2003

Treatment Designation	PARAMETER	ABV.	UNITS	Run 7				Run 8				Run 9				Run 10				Run 11				Run 12			
				Data Qualifier	Reason	=	Result	Data Qualifier	Reason	=	Result	Data Qualifier	Reason	=	Result	Data Qualifier	Reason	=	Result	Data Qualifier	Reason	=	Result	Data Qualifier	Reason	=	Result
CPSF	Run #	Run #	-				7				8				9				10				11				12
CPSF	Date of Collection	Date - Col	-				3/15/2003				3/15/2003				5/6/2003				5/6/2003				5/20/2003				5/27/2003
CPSF	Date Run (Day 1)	Date - Run					3/16/2003				3/18/2003				5/6/2003				5/8/2003				5/20/2003				5/27/2003
CPSF	Lab Name	Lab	-				Soil/Tox				Soil/Tox				Soil/Tox				Soil/Tox				Soil/Tox				Soil/Tox
CPSF	Water Source	Source	-				HY89+Boxes				Ski Run				HY89+Boxes				Ski Run				On-site				Snow Yard
CPSF	QC Type	QC-T	-				N/A				N/A				N/A				N/A				N/A				N/A
CPSF	QC Reference (dup of sample)	QC-R	-				N/A				N/A				N/A				N/A				N/A				N/A
CPSF	Unit (Sed., Filter, Mechanized, etc.)	Unit					Pres. Sand				Pres. Sand				Pres. Sand				Pres. Sand				Pres. Sand				Pres. Sand
CPSF	Chemical	Chem.	-				None				None				None				None				None				None
CPSF	Chemical Dose	Chem. Dose	mg/L				None				None				None				None				None				None
CPSF	Sedimentation Time	Sed. Time	hours				N/A				N/A				N/A				N/A				N/A				N/A
CPSF	Filter Media	Media	-				Sand				Sand				Sand				Sand				Sand				Sand
CPSF	Filter Loading (6 hour or "fast")	Loading	-				2.6 gpm				2.6 gpm				2.6 gpm				2.6 gpm				2.6 gpm				2.6 gpm
CPSF	Filter Outlet (free or submerged)	Filt. Outlet	-				N/A				N/A				N/A				N/A				N/A				N/A
CPSF	Pilot Plant ID #	Plant ID#	-				07-CPSF				08-CPSF				09-CPSF				10-CPSF				11-CPSF				12-CPSF
CPSF	Laboratory Log #	Lab #	-				T303046-20				T303052-32				T-305008-31				T-305011-27				T-305028-31				T-305040-02
CPSF	Alkalinity - total	Alk-T	mg-$CaCO_3$/L				24				21	U	x		24				41				17				20
CPSF	Aluminum - acid soluble	Al-AS	µg/L				48				59			<	25			<	25			<	25				50
CPSF	Aluminum - dissolved	Al-D	µg/L				39			<	25			<	25			<	25			<	25				73
CPSF	Aluminum - total	Al-T	µg/L				75				52				120			<	25				36	J	m		120
CPSF	Ammonia	NH_4	mg-N/L			<	0.1			<	0.1				0.12			<	0.1			<	0.1			<	0.1
CPSF	Conductivity (field)	EC	µmhos/cm				615				283				328				322				1418				302
CPSF	Iron - dissolved	Fe-D	µg/L				270			<	25				98			<	25			<	25				52
CPSF	Iron - total	Fe-T	µg/L				300			<	25				190			<	25	J	m		58				140
CPSF	Kjeldahl Nitrogen - dissolved	TKN-D	mg-N/L	U	x		0.25	J	Q		0.41	UJ	d,Q,x		0.38	U	x		0.23				0.21	UJ	d,x		0.28
CPSF	Kjeldahl Nitrogen - total	TKN-T	mg-N/L				0.17	J	Q		0.19	J	Q		0.23	U	x		0.16	U	x		0.20	U	x		0.20
CPSF	Nitrate Nitrogen	NO_3	mg-N/L				0.13			<	0.1				0.10	UJ	h	<	0.1	UJ	h	<	0.1			<	0.1
CPSF	Nitrite Nitrogen	NO_2	mg-N/L			<	0.1			<	0.1			<	0.1	UJ	h	<	0.1	UJ	h	<	0.1			<	0.1
CPSF	Oil & Grease	O&G	mg/L			<	2			<	2			<	2	UJ	h	<	2			<	2	CC		<	5*
CPSF	Organic Carbon - total	TOC	mg/L	J	m		6				5				5				2.2				1				2
CPSF	Orthophosphate - dissolved	OP-D	mg-P/L			<	0.03			<	0.03			<	0.03	UJ	h	<	0.03	UJ	h	<	0.03			<	0.03
CPSF	Orthophosphate - total	OP-T	mg-P/L			<	0.03			<	0.03			<	0.03	UJ	h	<	0.03	UJ	h	<	0.03			<	0.03
CPSF	pH (field)	pH	pH Units				7.1				6.5				6.6				6.9				6.7				6.7
CPSF	Phosphorus - dissolved	Phos-D	mg-P/L			<	0.03			<	0.03			<	0.03				0.05			<	0.03			<	0.03
CPSF	Phosphorus - total	Phos-T	mg-P/L			<	0.03			<	0.03			<	0.03			<	0.03			<	0.03			<	0.03
CPSF	Temperature (field)	Temp	°C				5.2				7.5				9.5				8.1				12.5				14.6
CPSF	Total Dissolved Solids	TDS	mg/L				308				152				156				202	U	x		720				138
CPSF	Total Nitrogen (calculated)	TN	mg-N/L				0.30				0.19				0.33				0.16				0.20				0.20
CPSF	Total Suspended Solids	TSS	mg/L			<	1			<	1			<	1			<	1			<	1			<	1
CPSF	Turbidity (field)	Turb	NTU				1.4				0.4				2.5				0.09				0.83				2.3

Caltrans Lake Tahoe Small-Scale Storm Water Treatment Pilot Plant

Phase II Water Quality Data, 2003

Treatment Designation	PARAMETER	ABV.	UNITS	Run 7	Run 8	Run 9	Run 10	Run 11	Run 12
				Data Qualifier Reason = Result	Data Qualifier Reason = Result	Data Qualifier Reason = Result	Data Qualifier Reason = Result	Data Qualifier Reason = Result	Data Qualifier Reason = Result
CC	Run #	Run #	-	7	8	9	10	11	12
CC	Date of Collection	Date - Col	-	3/15/2003	3/15/2003	5/6/2003	5/6/2003	5/20/2003	5/27/2003
CC	Date Run (Day 1)	Date - Run		3/16/2003	3/18/2003	5/6/2003	5/8/2003	5/20/2003	5/27/2003
CC	Lab Name	Lab	-	Soil/Tox	Soil/Tox	Soil/Tox	Soil/Tox	Soil/Tox	Soil/Tox
CC	Water Source	Source	-	HY89+Boxes	Ski Run	HY89+Boxes	Ski Run	On-site	Snow Yard
CC	QC Type	QC-T	-	N/A	N/A	N/A	N/A	N/A	N/A
CC	QC Reference (dup of sample)	QC-R	-	N/A	N/A	N/A	N/A	N/A	N/A
CC	Unit (Sed., Filter, Mechanized, etc.)	Unit		Cation	Cation	Cation	Cation	Cation	Cation
CC	Chemical	Chem.	-	None	None	None	None	None	None
CC	Chemical Dose	Chem. Dose	mg/L	None	None	None	None	None	None
CC	Sedimentation Time	Sed. Time	hours	N/A	N/A	N/A	N/A	N/A	N/A
CC	Filter Media	Media	-	IX Resin	IX Resin	IX Resin	IX Resin	IX Resin	IX Resin
CC	Filter Loading (6 hour or "fast")	Loading	-	2.6 gpm	2.6 gpm	2.6 gpm	2.6 gpm	2.6 gpm	2.6 gpm
CC	Filter Outlet (free or submerged)	Filt. Outlet	-	N/A	N/A	N/A	N/A	N/A	N/A
CC	Pilot Plant ID #	Plant ID#	-	Not Sampled	Not Sampled	Not Sampled	Not Sampled	Not Sampled	Not Sampled
CC	Laboratory Log #	Lab #	-						
CC	Alkalinity - total	Alk-T	mg-$CaCO_3$/L						
CC	Aluminum - acid soluble	Al-AS	µg/L						
CC	Aluminum - dissolved	Al-D	µg/L						
CC	Aluminum - total	Al-T	µg/L						
CC	Ammonia	NH_4	mg-N/L						
CC	Conductivity (field)	EC	µmhos/cm						
CC	Iron - dissolved	Fe-D	µg/L						
CC	Iron - total	Fe-T	µg/L						
CC	Kjeldahl Nitrogen - dissolved	TKN-D	mg-N/L						
CC	Kjeldahl Nitrogen - total	TKN-T	mg-N/L						
CC	Nitrate Nitrogen	NO_3	mg-N/L						
CC	Nitrite Nitrogen	NO_2	mg-N/L						
CC	Oil & Grease	O&G	mg/L						
CC	Organic Carbon - total	TOC	mg/L						
CC	Orthophosphate - dissolved	OP-D	mg-P/L						
CC	Orthophosphate - total	OP-T	mg-P/L						
CC	pH (field)	pH	pH Units						
CC	Phosphorus - dissolved	Phos-D	mg-P/L						
CC	Phosphorus - total	Phos-T	mg-P/L						
CC	Temperature (field)	Temp	°C						
CC	Total Dissolved Solids	TDS	mg/L						
CC	Total Nitrogen (calculated)	TN	mg-N/L						
CC	Total Suspended Solids	TSS	mg/L						
CC	Turbidity (field)	Turb	NTU						

Caltrans Lake Tahoe Small-Scale Storm Water Treatment Pilot Plant

Phase II Water Quality Data, 2003

Treatment Designation	PARAMETER	ABV.	UNITS	Run 7				Run 8				Run 9				Run 10				Run 11				Run 12			
				Data Qualifier	Reason	=	Result	Data Qualifier	Reason	=	Result	Data Qualifier	Reason	=	Result	Data Qualifier	Reason	=	Result	Data Qualifier	Reason	=	Result	Data Qualifier	Reason	=	Result
CCA	Run #	Run #	-				7				8				9				10				11				12
CCA	Date of Collection	Date - Col	-				3/15/2003				3/15/2003				5/6/2003				5/6/2003				5/20/2003				5/27/2003
CCA	Date Run (Day 1)	Date - Run					3/16/2003				3/18/2003				5/6/2003				5/8/2003				5/20/2003				5/27/2003
CCA	Lab Name	Lab	-				Soil/Tox				Soil/Tox				Soil/Tox				Soil/Tox				Soil/Tox				Soil/Tox
CCA	Water Source	Source	-				HY89+Boxes				Ski Run				HY89+Boxes				Ski Run				On-site				Snow Yard
CCA	QC Type	QC-T	-				N/A				N/A				N/A				N/A				N/A				N/A
CCA	QC Reference (dup of sample)	QC-R	-				N/A				N/A				N/A				N/A				N/A				N/A
CCA	Unit (Sed., Filter, Mechanized, etc.)	Unit					Anion				Anion				Anion				Anion				Anion				Anion
CCA	Chemical	Chem.	-				None				None				None				None				None				None
CCA	Chemical Dose	Chem. Dose	mg/L				None				None				None				None				None				None
CCA	Sedimentation Time	Sed. Time	hours				N/A				N/A				N/A				N/A				N/A				N/A
CCA	Filter Media	Media	-				IX Resin				IX Resin				IX Resin				IX Resin				IX Resin				IX Resin
CCA	Filter Loading (6 hour or "fast")	Loading	-				2.6 gpm				2.6 gpm				2.6 gpm				2.6 gpm				2.6 gpm				2.6 gpm
CCA	Filter Outlet (free or submerged)	Filt. Outlet	-				N/A				N/A				N/A				N/A				N/A				N/A
CCA	Pilot Plant ID #	Plant ID#	-				07-CCA				08-CCA				09-CCA				10-CCA				11-CCA				12-CCA
CCA	Laboratory Log #	Lab #	-				T303046-05				T303052-30				T-305008-29				T-305011-25				T-305028-29				T-305040-01
CCA	Alkalinity - total	Alk-T	mg-$CaCO_3$/L				28				19	U	x		20				22				18				16
CCA	Aluminum - acid soluble	Al-AS	µg/L				29				39			<	25			<	25			<	25				30
CCA	Aluminum - dissolved	Al-D	µg/L				35			<	25			<	25			<	25			<	25				62
CCA	Aluminum - total	Al-T	µg/L				53				37			<	25			<	25				27	J	m		62
CCA	Ammonia	NH_4	mg-N/L			<	0.1			<	0.1			<	0.1			<	0.1			<	0.1			<	0.1
CCA	Conductivity (field)	EC	µmhos/cm				590				280				332				338				1413				307
CCA	Iron - dissolved	Fe-D	µg/L			<	25			<	25			<	25			<	25			<	25			<	25
CCA	Iron - total	Fe-T	µg/L			<	25			<	25			<	25			<	25	UJ	m	<	25				36
CCA	Kjeldahl Nitrogen - dissolved	TKN-D	mg-N/L	U	x		0.22				0.22	UJ	d,Q,x		0.24	U	x		0.22	U	x		0.13	UJ	d,Q,x		0.28
CCA	Kjeldahl Nitrogen - total	TKN-T	mg-N/L				0.15				0.12	J	Q		0.12	U	x		0.15	U	x		0.16	UJ	Q,x		0.10
CCA	Nitrate Nitrogen	NO_3	mg-N/L			<	0.1				0.13			<	0.1	UJ	h	<	0.1	UJ	h	<	0.1			<	0.1
CCA	Nitrite Nitrogen	NO_2	mg-N/L			<	0.1			<	0.1			<	0.1	UJ	h	<	0.1	UJ	h	<	0.1			<	0.1
CCA	Oil & Grease	O&G	mg/L			<	2			<	2			<	2	UJ	h	<	2			<	2			<	2
CCA	Organic Carbon - total	TOC	mg/L				3				2				2			<	1			<	1			<	1
CCA	Orthophosphate - dissolved	OP-D	mg-P/L			<	0.03			<	0.03			<	0.03	UJ	h	<	0.03	UJ	h	<	0.03			<	0.03
CCA	Orthophosphate - total	OP-T	mg-P/L			<	0.03			<	0.03			<	0.03	UJ	h	<	0.03	UJ	h	<	0.03			<	0.03
CCA	pH (field)	pH	pH Units				7.2				6.8				6.5				6.6				6.8				6.7
CCA	Phosphorus - dissolved	Phos-D	mg-P/L			<	0.03			<	0.03			<	0.03				0.05			<	0.03			<	0.03
CCA	Phosphorus - total	Phos-T	mg-P/L			<	0.03			<	0.03			<	0.03				0.04			<	0.03			<	0.03
CCA	Temperature (field)	Temp	°C				4.9				7.3				9.3				8.1				12.6				15.0
CCA	Total Dissolved Solids	TDS	mg/L				282				128				158				180	U	x		712				142
CCA	Total Nitrogen (calculated)	TN	mg-N/L				0.15				0.25				0.12				0.15				0.16				0.10
CCA	Total Suspended Solids	TSS	mg/L			<	1			<	1			<	1			<	1	U	x		2			<	1
CCA	Turbidity (field)	Turb	NTU				0.5				0.4				0.12				0.09				0.48				1.4

Caltrans Lake Tahoe Small-Scale Storm Water Treatment Pilot Plant

Phase II Water Quality Data, 2003

Treatment Designation	PARAMETER	ABV.	UNITS	Run 7				Run 8				Run 9				Run 10				Run 11				Run 12			
				Data Qualifier	Reason	=	Result	Data Qualifier	Reason	=	Result	Data Qualifier	Reason	=	Result	Data Qualifier	Reason	=	Result	Data Qualifier	Reason	=	Result	Data Qualifier	Reason	=	Result
41-S	Run #	Run #	-				7				8				9				10				11				12
41-S	Date of Collection	Date - Col	-				3/15/2003				3/15/2003				5/6/2003				5/6/2003				5/20/2003				5/27/2003
41-S	Date Run (Day 1)	Date - Run					3/16/2003				3/18/2003				5/6/2003				5/8/2003				5/20/2003				5/27/2003
41-S	Lab Name	Lab	-				Soil/Tox				Soil/Tox				Soil/Tox				Soil/Tox				Soil/Tox				Soil/Tox
41-S	Water Source	Source	-				HY89+Boxes				Ski Run				HY89+Boxes				Ski Run				On-site				Snow Yard
41-S	QC Type	QC-T	-				Duplicate				Duplicate				Duplicate				Duplicate				Duplicate				Duplicate
41-S	QC Reference (dup of sample)	QC-R	-				07-I-01				08-I-01				09-I-01				10-I-01				11-I-01				12-I-01
41-S	Unit (Sed., Filter, Mechanized, etc.)	Unit					Influent				Influent				Influent				Influent				Influent				Influent
41-S	Chemical	Chem.	-				None				None				None				None				None				None
41-S	Chemical Dose	Chem. Dose	mg/L				None				None				None				None				None				None
41-S	Sedimentation Time	Sed. Time	hours				N/A				N/A				N/A				N/A				N/A				N/A
41-S	Filter Media	Media	-				N/A				N/A				N/A				N/A				N/A				N/A
41-S	Filter Loading (6 hour or "fast")	Loading	-				N/A				N/A				N/A				N/A				N/A				N/A
41-S	Filter Outlet (free or submerged)	Filt. Outlet	-				N/A				N/A				N/A				N/A				N/A				N/A
41-S	Pilot Plant ID #	Plant ID#	-				07-41-S				08-41-S				09-41-S				10-41-S				11-41-S				12-41-S
41-S	Laboratory Log #	Lab #	-				T303046-02				T303052-07				T-305008-06				T-305011-23				T-305028-07				T-305040-08
41-S	Alkalinity - total	Alk-T	mg-$CaCO_3$/L				29				28	U	x		37				63				24				30
41-S	Aluminum - acid soluble	Al-AS	µg/L				500				260				140				33				920				600
41-S	Aluminum - dissolved	Al-D	µg/L				27	U	x		34			<	25			<	25			<	25			<	25
41-S	Aluminum - total	Al-T	µg/L				11000				6900				2300				390				21000	J	m		18000
41-S	Ammonia	NH_4	mg-N/L			<	0.1			<	0.1				0.15			<	0.1			<	0.1			<	0.1
41-S	Conductivity (field)	EC	µmhos/cm				612				242				303				276				1433				256
41-S	Iron - dissolved	Fe-D	µg/L				48				36				120				40			<	25			<	25
41-S	Iron - total	Fe-T	µg/L				10000				6300				2900				800				20000				20000
41-S	Kjeldahl Nitrogen - dissolved	TKN-D	mg-N/L	UJ	f,x		0.22				0.58	J	f,Q		1.3	UJ	f,x		0.19	U	x		0.15	UJ	d	<	0.1
41-S	Kjeldahl Nitrogen - total	TKN-T	mg-N/L				1.4				0.97	J	d,Q		0.70	U	x		0.26	J	d		0.94				0.95
41-S	Nitrate Nitrogen	NO_3	mg-N/L			<	0.1			<	0.1	UJ	h	<	0.1	UJ	h	<	0.1			<	0.1			<	0.1
41-S	Nitrite Nitrogen	NO_2	mg-N/L			<	0.1			<	0.1	UJ	h	<	0.1	UJ	h	<	0.1			<	0.1			<	0.1
41-S	Oil & Grease	O&G	mg/L				10				5			<	2	UJ	h	<	2				8			<	2
41-S	Organic Carbon - total	TOC	mg/L				11				15				15				5.2	J	f		10				14
41-S	Orthophosphate - dissolved	OP-D	mg-P/L			<	0.03			<	0.03	UJ	h	<	0.03	UJ	h	<	0.03				0.04			<	0.03
41-S	Orthophosphate - total	OP-T	mg-P/L				0.43				0.21	UJ	h,x		0.06	UJ	h	<	0.03				0.70				0.25
41-S	pH (field)	pH	pH Units				8.0				6.7				6.9				7.9				7.4				7.3
41-S	Phosphorus - dissolved	Phos-D	mg-P/L			<	0.03				0.04			<	0.03				0.09				0.06			<	0.03
41-S	Phosphorus - total	Phos-T	mg-P/L				0.54				0.47				0.17				0.10				0.68				0.88
41-S	Temperature (field)	Temp	°C				3.0				6.6				9.4				8.1				11.2				15.6
41-S	Total Dissolved Solids	TDS	mg/L				320				152				162				180	U	x		784				276
41-S	Total Nitrogen (calculated)	TN	mg-N/L				1.4				0.97				0.70				0.26				0.94				0.95
41-S	Total Suspended Solids	TSS	mg/L				364				172				58				22				492				252
41-S	Turbidity (field)	Turb	NTU				416				194				61.1				15.5				566				581

Caltrans Lake Tahoe Small-Scale Storm Water Treatment Pilot Plant

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Treatment Designation	PARAMETER	ABV.	UNITS	Run 7				Run 8				Run 9				Run 10				Run 11				Run 12			
				Data Qualifier	Reason	=	Result	Data Qualifier	Reason	=	Result	Data Qualifier	Reason	=	Result	Data Qualifier	Reason	=	Result	Data Qualifier	Reason	=	Result	Data Qualifier	Reason	=	Result
41-F	Run #	Run #	-				7				8				9				10				11				12
41-F	Date of Collection	Date - Col	-				3/15/2003				3/15/2003				5/6/2003				5/6/2003				5/20/2003				5/27/2003
41-F	Date Run (Day 1)	Date - Run					3/16/2003				3/18/2003				5/6/2003				5/8/2003				5/20/2003				5/27/2003
41-F	Lab Name	Lab	-				Soil/Tox				Soil/Tox				Soil/Tox				Soil/Tox				Soil/Tox				Soil/Tox
41-F	Water Source	Source	-				HY89+Boxes				Ski Run				HY89+Boxes				Ski Run				On-site				Snow Yard
41-F	QC Type	QC-T	-				Duplicate				Duplicate				Duplicate				Duplicate				Duplicate				Duplicate
41-F	QC Reference (dup of sample)	QC-R	-				07-PFF				08-35-F				09-PFF				10-PA				11-PFF				12-PA
41-F	Unit (Sed., Filter, Mechanized, etc.)	Unit					N/A				N/A				N/A				N/A				N/A				N/A
41-F	Chemical	Chem.	-				N/A				N/A				N/A				N/A				N/A				N/A
41-F	Chemical Dose	Chem. Dose	mg/L				N/A				N/A				N/A				N/A				N/A				N/A
41-F	Sedimentation Time	Sed. Time	hours				N/A				N/A				N/A				N/A				N/A				N/A
41-F	Filter Media	Media	-				N/A				N/A				N/A				N/A				N/A				N/A
41-F	Filter Loading (6 hour or "fast")	Loading	-				N/A				N/A				N/A				N/A				N/A				N/A
41-F	Filter Outlet (free or submerged)	Filt. Outlet	-				N/A				N/A				N/A				N/A				N/A				N/A
41-F	Pilot Plant ID #	Plant ID#	-				07-41-F				08-41-F				09-41-F				10-41-F				11-41-F				12-41-F
41-F	Laboratory Log #	Lab #	-				T303046-12				T303052-09				T-305008-12				T-305011-22				T-305028-09				T-305040-18
41-F	Alkalinity - total	Alk-T	mg-$CaCO_3$/L				24				36	U	x		20				41				14				18
41-F	Aluminum - acid soluble	Al-AS	µg/L				64				160				60				120			<	25				83
41-F	Aluminum - dissolved	Al-D	µg/L				33			<	25			<	25				25			<	25	J	f		51
41-F	Aluminum - total	Al-T	µg/L				43				3900				64				140				39	J	m		130
41-F	Ammonia	NH_4	mg-N/L			<	0.1			<	0.1				0.11			<	0.1			<	0.1			<	0.1
41-F	Conductivity (field)	EC	µmhos/cm				627				298				328				321				1425				295
41-F	Iron - dissolved	Fe-D	µg/L			<	25			<	25	UJ	f	<	25			<	25			<	25			<	25
41-F	Iron - total	Fe-T	µg/L			<	25				3300			<	25				25				30				100
41-F	Kjeldahl Nitrogen - dissolved	TKN-D	mg-N/L	U	x		0.24				0.62	UJ	Q,x		0.42	U	x		0.23	U	x		0.22	UJ	Q,x		0.38
41-F	Kjeldahl Nitrogen - total	TKN-T	mg-N/L				0.22				0.62	J	d,Q		0.25	U	x		0.24	U	x		0.24	UJ	Q,x		0.18
41-F	Nitrate Nitrogen	NO_3	mg-N/L				0.10			<	0.1			<	0.1	UJ	h	<	0.1			<	0.1			<	0.1
41-F	Nitrite Nitrogen	NO_2	mg-N/L			<	0.1			<	0.1			<	0.1	UJ	h	<	0.1			<	0.1			<	0.1
41-F	Oil & Grease	O&G	mg/L			<	2				2			<	2	UJ	h	<	2			<	2			<	2
41-F	Organic Carbon - total	TOC	mg/L				6				12				5				2.4				1				2
41-F	Orthophosphate - dissolved	OP-D	mg-P/L			<	0.03				0.04			<	0.03	UJ	h	<	0.03			<	0.03			<	0.03
41-F	Orthophosphate - total	OP-T	mg-P/L			<	0.03				0.16			<	0.03	UJ	h	<	0.03			<	0.03			<	0.03
41-F	pH (field)	pH	pH Units				7.0				6.9				6.5				6.8				6.7				6.6
41-F	Phosphorus - dissolved	Phos-D	mg-P/L			<	0.03				0.08			<	0.03			<	0.03			<	0.03			<	0.03
41-F	Phosphorus - total	Phos-T	mg-P/L			<	0.03				0.34			<	0.03				0.05			<	0.03			<	0.03
41-F	Temperature (field)	Temp	°C				4.6				4.9				8.4				8.2				11.1				14.6
41-F	Total Dissolved Solids	TDS	mg/L				298				178				160				200	U	x		708				134
41-F	Total Nitrogen (calculated)	TN	mg-N/L				0.32				0.62				0.25				0.24				0.24				0.18
41-F	Total Suspended Solids	TSS	mg/L	UJ	f,x		6				72			<	1			<	1	UJ	h	<	1			<	1
41-F	Turbidity (field)	Turb	NTU				0.8				117				0.34				0.34				0.85				3.5

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Treatment Designation	PARAMETER	ABV.	UNITS	Run 7				Run 8				Run 9				Run 10				Run 11				Run 12			
				Data Qualifier	Reason	=	Result	Data Qualifier	Reason	=	Result	Data Qualifier	Reason	=	Result	Data Qualifier	Reason	=	Result	Data Qualifier	Reason	=	Result	Data Qualifier	Reason	=	Result
42-S	Run #	Run #	-				7				8				9				10				11				12
42-S	Date of Collection	Date - Col	-				3/15/2003				3/15/2003				5/6/2003				5/6/2003				5/20/2003				5/27/2003
42-S	Date Run (Day 1)	Date - Run					3/16/2003				3/18/2003				5/6/2003				5/8/2003				5/20/2003				5/27/2003
42-S	Lab Name	Lab	-				Soil/Tox				Soil/Tox				Soil/Tox				Soil/Tox				Soil/Tox				Soil/Tox
42-S	Water Source	Source	-				HY89+Boxes				Ski Run				HY89+Boxes				Ski Run				On-site				Snow Yard
42-S	QC Type	QC-T	-				Duplicate				Duplicate				Duplicate				Duplicate				Duplicate				Duplicate
42-S	QC Reference (dup of sample)	QC-R	-				07-30-S				08-PCA				09-30-S				10-38-S				11-30-S				12-38-S
42-S	Unit (Sed., Filter, Mechanized, etc.)	Unit					N/A				N/A				N/A				N/A				N/A				N/A
42-S	Chemical	Chem.	-				N/A				N/A				N/A				N/A				N/A				N/A
42-S	Chemical Dose	Chem. Dose	mg/L				N/A				N/A				N/A				N/A				N/A				N/A
42-S	Sedimentation Time	Sed. Time	hours				N/A				N/A				N/A				N/A				N/A				N/A
42-S	Filter Media	Media	-				N/A				N/A				N/A				N/A				N/A				N/A
42-S	Filter Loading (6 hour or "fast")	Loading	-				N/A				N/A				N/A				N/A				N/A				N/A
42-S	Filter Outlet (free or submerged)	Filt. Outlet	-				N/A				N/A				N/A				N/A				N/A				N/A
42-S	Pilot Plant ID #	Plant ID#	-				07-40-S (ok)				08-42-S				09-42-S				10-42-S				11-42-S				12-42-S
42-S	Laboratory Log #	Lab #	-				T303046-33				T303052-21				T-305008-25				T-305011-24				T-305028-28				T-305040-31
42-S	Alkalinity - total	Alk-T	mg-$CaCO_3$/L				30				13	U	x		37				59				22				29
42-S	Aluminum - acid soluble	Al-AS	µg/L				309			<	25				96			<	25			<	25				510
42-S	Aluminum - dissolved	Al-D	µg/L			<	25			<	25				27			<	25			<	25			<	25
42-S	Aluminum - total	Al-T	µg/L				5200				28				630				70				220	J	m		17000
42-S	Ammonia	NH_4	mg-N/L			<	0.1			<	0.1			<	0.1			<	0.1			<	0.1			<	0.1
42-S	Conductivity (field)	EC	µmhos/cm				554				303				291				277				1400				261
42-S	Iron - dissolved	Fe-D	µg/L				38			<	25				26				33			<	25			<	25
42-S	Iron - total	Fe-T	µg/L				4500			<	25				920				220	J	m		170				18000
42-S	Kjeldahl Nitrogen - dissolved	TKN-D	mg-N/L	U	x		0.25				0.21	UJ	d,x		0.36	UJ	Q,x		0.31	U	x		0.16	UJ	f,x		0.42
42-S	Kjeldahl Nitrogen - total	TKN-T	mg-N/L				0.69				0.15				0.57	UJ	Q,x		0.19			<	0.1				0.78
42-S	Nitrate Nitrogen	NO_3	mg-N/L			<	0.1			<	0.1				0.10				0.72			<	0.1	R	f	<	0.1
42-S	Nitrite Nitrogen	NO_2	mg-N/L			<	0.1			<	0.1			<	0.1			<	0.1			<	0.1			<	0.1
42-S	Oil & Grease	O&G	mg/L			<	3			<	2			<	2			<	2			<	2			<	2
42-S	Organic Carbon - total	TOC	mg/L	UJ	f	<	1				2				10				5.2				2	R	f	<	1
42-S	Orthophosphate - dissolved	OP-D	mg-P/L			<	0.03			<	0.03			<	0.03			<	0.03				0.04			<	0.03
42-S	Orthophosphate - total	OP-T	mg-P/L				0.14			<	0.03			<	0.03			<	0.03				0.04				0.20
42-S	pH (field)	pH	pH Units				7.0				6.7				6.8				7.8				7.3				7.3
42-S	Phosphorus - dissolved	Phos-D	mg-P/L			<	0.03			<	0.03			<	0.03				0.08				0.06			<	0.03
42-S	Phosphorus - total	Phos-T	mg-P/L				0.24			<	0.03	UJ	f	<	0.03				0.10				0.06				0.69
42-S	Temperature (field)	Temp	°C				2.8				6.1				7.5				7.5				12.9				16.6
42-S	Total Dissolved Solids	TDS	mg/L				312				148				152				180	U	x		694				268
42-S	Total Nitrogen (calculated)	TN	mg-N/L				0.69				0.15				0.67				0.91			<	0.1				0.78
42-S	Total Suspended Solids	TSS	mg/L				110			<	1				28			<	1	U	x		4				124
42-S	Turbidity (field)	Turb	NTU				162				0.3				40.1				5.6				4.4				489

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Treatment Designation	PARAMETER	ABV.	UNITS	Run 7		Run 8		Run 9		Run 10		Run 11		Run 12	
				Data Qualifier	Result Reason =	Data Qualifier	Result Reason =	Data Qualifier	Result Reason =	Data Qualifier	Result Reason =	Data Qualifier	Result Reason =	Data Qualifier	Result Reason =
42-F	Run #	Run #	-		7		8		9		10		11		12
42-F	Date of Collection	Date - Col	-		3/15/2003		3/15/2003		5/6/2003		5/6/2003		5/20/2003		5/27/2003
42-F	Date Run (Day 1)	Date - Run			3/16/2003		3/18/2003		5/6/2003		5/8/2003		5/20/2003		5/27/2003
42-F	Lab Name	Lab	-		Soil/Tox		Soil/Tox		Soil/Tox		Soil/Tox		Soil/Tox		Soil/Tox
42-F	Water Source	Source	-		HY89+Boxes		Ski Run		HY89+Boxes		Ski Run		On-site		Snow Yard
42-F	QC Type	QC-T	-		-		-		-		-		-		-
42-F	QC Reference (dup of sample)	QC-R	-		-		-		-		-		-		-
42-F	Unit (Sed., Filter, Mechanized, etc.)	Unit			N/A		N/A		N/A		N/A		N/A		N/A
42-F	Chemical	Chem.	-		N/A		N/A		N/A		N/A		N/A		N/A
42-F	Chemical Dose	Chem. Dose	mg/L		N/A		N/A		N/A		N/A		N/A		N/A
42-F	Sedimentation Time	Sed. Time	hours		N/A		N/A		N/A		N/A		N/A		N/A
42-F	Filter Media	Media	-		N/A		N/A		N/A		N/A		N/A		N/A
42-F	Filter Loading (6 hour or "fast")	Loading	-		N/A		N/A		N/A		N/A		N/A		N/A
42-F	Filter Outlet (free or submerged)	Filt. Outlet	-		N/A		N/A		N/A		N/A		N/A		N/A
42-F	Pilot Plant ID #	Plant ID#	-		No Sample		No Sample		No Sample		No Sample		No Sample		No Sample
42-F	Laboratory Log #	Lab #	-												
42-F	Alkalinity - total	Alk-T	mg-$CaCO_3$/L												
42-F	Aluminum - acid soluble	Al-AS	µg/L												
42-F	Aluminum - dissolved	Al-D	µg/L												
42-F	Aluminum - total	Al-T	µg/L												
42-F	Ammonia	NH_4	mg-N/L												
42-F	Conductivity (field)	EC	µmhos/cm												
42-F	Iron - dissolved	Fe-D	µg/L												
42-F	Iron - total	Fe-T	µg/L												
42-F	Kjeldahl Nitrogen - dissolved	TKN-D	mg-N/L												
42-F	Kjeldahl Nitrogen - total	TKN-T	mg-N/L												
42-F	Nitrate Nitrogen	NO_3	mg-N/L												
42-F	Nitrite Nitrogen	NO_2	mg-N/L												
42-F	Oil & Grease	O&G	mg/L												
42-F	Organic Carbon - total	TOC	mg/L												
42-F	Orthophosphate - dissolved	OP-D	mg-P/L												
42-F	Orthophosphate - total	OP-T	mg-P/L												
42-F	pH (field)	pH	pH Units												
42-F	Phosphorus - dissolved	Phos-D	mg-P/L												
42-F	Phosphorus - total	Phos-T	mg-P/L												
42-F	Temperature (field)	Temp	°C												
42-F	Total Dissolved Solids	TDS	mg/L												
42-F	Total Nitrogen (calculated)	TN	mg-N/L												
42-F	Total Suspended Solids	TSS	mg/L												
42-F	Turbidity (field)	Turb	NTU												

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Treatment Designation	PARAMETER	ABV.	UNITS	Run 7			Run 8			Run 9			Run 10			Run 11			Run 12		
				Data Qualifier	Reason	Result =	Data Qualifier	Reason	Result =	Data Qualifier	Reason	Result =	Data Qualifier	Reason	Result =	Data Qualifier	Reason	Result =	Data Qualifier	Reason	Result =
43-S	Run #	Run #	-			7			8			9			10			11			12
43-S	Date of Collection	Date - Col	-			3/15/2003			3/15/2003			5/6/2003			5/6/2003			5/20/2003			5/27/2003
43-S	Date Run (Day 1)	Date - Run				3/16/2003			3/18/2003			5/6/2003			5/8/2003			5/20/2003			5/27/2003
43-S	Lab Name	Lab	-			Soil/Tox			Soil/Tox			Soil/Tox			Soil/Tox			Soil/Tox			Soil/Tox
43-S	Water Source	Source	-			HPLC			HPLC			HPLC			HPLC			HPLC			HPLC
43-S	QC Type	QC-T	-			Bot. Blank			Bot. Blank			Bot. Blank			Bot. Blank			Bot. Blank			Bot. Blank
43-S	QC Reference (dup of sample)	QC-R	-			Runs 7&8			Runs 7&8			Runs 9&10			Runs 9&10			Run 11			Run 12
43-S	Unit (Sed., Filter, Mechanized, etc.)	Unit				N/A			N/A			N/A			N/A			N/A			N/A
43-S	Chemical	Chem.	-			N/A			N/A			N/A			N/A			N/A			N/A
43-S	Chemical Dose	Chem. Dose	mg/L			N/A			N/A			N/A			N/A			N/A			N/A
43-S	Sedimentation Time	Sed. Time	hours			N/A			N/A			N/A			N/A			N/A			N/A
43-S	Filter Media	Media	-			N/A			N/A			N/A			N/A			N/A			N/A
43-S	Filter Loading (6 hour or "fast")	Loading	-			N/A			N/A			N/A			N/A			N/A			N/A
43-S	Filter Outlet (free or submerged)	Filt. Outlet	-			N/A			N/A			N/A			N/A			N/A			N/A
43-S	Pilot Plant ID #	Plant ID#	-			07-43-S			08-43-S			09-43-S			10-43-S			11-43-S			12-43-S
43-S	Laboratory Log #	Lab #	-			T303046-16			T303052-08			T-305008-08			T-305011-02			T-305028-11			T-305040-04
43-S	Alkalinity - total	Alk-T	mg-$CaCO_3$/L			< 1			< 1			< 1			< 1			< 1			2
43-S	Aluminum - acid soluble	Al-AS	µg/L			< 25			< 25			< 25			< 25			< 25			< 25
43-S	Aluminum - dissolved	Al-D	µg/L			< 25			< 25			< 25			< 25			< 25			< 25
43-S	Aluminum - total	Al-T	µg/L			< 25			< 25			< 25			< 25			< 25			< 25
43-S	Ammonia	NH_4	mg-N/L			< 0.1			< 0.1			< 0.1			< 0.1			< 0.1			< 0.1
43-S	Conductivity (field)	EC	µmhos/cm			< 1			< 1			< 1			1			< 1			< 1
43-S	Iron - dissolved	Fe-D	µg/L			< 25			< 25			< 25			< 25			< 25			< 25
43-S	Iron - total	Fe-T	µg/L			< 25			< 25			< 25			< 25			< 25			< 25
43-S	Kjeldahl Nitrogen - dissolved	TKN-D	mg-N/L			< 0.1			< 0.1			< 0.1			0.11			< 0.1			< 0.1
43-S	Kjeldahl Nitrogen - total	TKN-T	mg-N/L			< 0.1			< 0.1			< 0.1			0.18			0.13			< 0.1
43-S	Nitrate Nitrogen	NO_3	mg-N/L			< 0.1			< 0.1	UJ	h	< 0.1			< 0.1			< 0.1			< 0.1
43-S	Nitrite Nitrogen	NO_2	mg-N/L			< 0.1			< 0.1	UJ	h	< 0.1			< 0.1			< 0.1			< 0.1
43-S	Oil & Grease	O&G	mg/L			< 2			< 2			< 2			< 2			< 2			< 2
43-S	Organic Carbon - total	TOC	mg/L			< 1			< 1			< 1			< 1			< 1			< 1
43-S	Orthophosphate - dissolved	OP-D	mg-P/L			< 0.03			< 0.03	UJ	h	< 0.03			< 0.03			< 0.03			< 0.03
43-S	Orthophosphate - total	OP-T	mg-P/L			< 0.03			< 0.03	UJ	h	< 0.03			< 0.03			< 0.03			< 0.03
43-S	pH (field)	pH	pH Units			8.2			6.9			5.6			5.7			5.7			5.8
43-S	Phosphorus - dissolved	Phos-D	mg-P/L			< 0.03			< 0.03			< 0.03			< 0.03			< 0.03			< 0.03
43-S	Phosphorus - total	Phos-T	mg-P/L			< 0.03			< 0.03			< 0.03			< 0.03			< 0.03			< 0.03
43-S	Temperature (field)	Temp	°C			6.7			3.1			9.1			7.8			14.9			19.0
43-S	Total Dissolved Solids	TDS	mg/L			< 1			8			< 1			< 1			< 1			< 1
43-S	Total Nitrogen (calculated)	TN	mg-N/L			< 0.1			< 0.1			< 0.1			0.18			0.13			< 0.1
43-S	Total Suspended Solids	TSS	mg/L			< 1			< 1			< 1			< 1			< 1			< 1
43-S	Turbidity (field)	Turb	NTU			< 0.1			< 0.1			0.07			0.07			0.07			0.06

Caltrans Lake Tahoe Small-Scale Storm Water Treatment Pilot Plant

Phase II Water Quality Data, 2003

Treatment Designation	PARAMETER	ABV.	UNITS	Run 7			Run 8			Run 9			Run 10			Run 11			Run 12		
				Data Qualifier	Reason	Result =	Data Qualifier	Reason	Result =	Data Qualifier	Reason	Result =	Data Qualifier	Reason	Result =	Data Qualifier	Reason	Result =	Data Qualifier	Reason	Result =
43-F	Run #	Run #	-			7			8			9			10			11			12
43-F	Date of Collection	Date - Col	-			3/15/2003			3/15/2003			5/6/2003			5/6/2003			5/20/2003			5/27/2003
43-F	Date Run (Day 1)	Date - Run				3/16/2003			3/18/2003			5/6/2003			5/8/2003			5/20/2003			5/27/2003
43-F	Lab Name	Lab	-			Soil/Tox			Soil/Tox			Soil/Tox			Soil/Tox			Soil/Tox			Soil/Tox
43-F	Water Source	Source	-			HPLC			HPLC			HPLC			HPLC			HPLC			HPLC
43-F	QC Type	QC-T	-			Process Blk			Process Blk			Process Blk			Process Blk			Process Blk			Process Blk
43-F	QC Reference (dup of sample)	QC-R	-			Runs 7&8			Runs 7&8			Runs 9&10			Runs 9&10			Run 11			Run 12
43-F	Unit (Sed., Filter, Mechanized, etc.)	Unit				N/A			N/A			N/A			N/A			N/A			N/A
43-F	Chemical	Chem.	-			N/A			N/A			N/A			N/A			N/A			N/A
43-F	Chemical Dose	Chem. Dose	mg/L			N/A			N/A			N/A			N/A			N/A			N/A
43-F	Sedimentation Time	Sed. Time	hours			N/A			N/A			N/A			N/A			N/A			N/A
43-F	Filter Media	Media	-			N/A			N/A			N/A			N/A			N/A			N/A
43-F	Filter Loading (6 hour or "fast")	Loading	-			N/A			N/A			N/A			N/A			N/A			N/A
43-F	Filter Outlet (free or submerged)	Filt. Outlet	-			N/A			N/A			N/A			N/A			N/A			N/A
43-F	Pilot Plant ID #	Plant ID#	-			07-43-F			08-43-F			09-43-F			10-43-F			11-43-F			12-43-F
43-F	Laboratory Log #	Lab #	-			T303046-19			T303052-15			T-305008-04			T-305011-01			T-305028-10			T-305040-05
43-F	Alkalinity - total	Alk-T	mg-$CaCO_3$/L			< 1			< 1			29			< 1			< 1			2
43-F	Aluminum - acid soluble	Al-AS	µg/L			< 25			< 25			< 25			< 25			< 25			< 25
43-F	Aluminum - dissolved	Al-D	µg/L			< 25			< 25			< 25			< 25			< 25			< 25
43-F	Aluminum - total	Al-T	µg/L			< 25			< 25			< 25			< 25			< 25			< 25
43-F	Ammonia	NH_4	mg-N/L			< 0.1			< 0.1			< 0.1			0.12			< 0.1			< 0.1
43-F	Conductivity (field)	EC	µmhos/cm			< 1			< 1			< 1			1			1			< 1
43-F	Iron - dissolved	Fe-D	µg/L			< 25			< 25			< 25			< 25			< 25			< 25
43-F	Iron - total	Fe-T	µg/L			< 25			< 25			< 25			< 25			< 25			< 25
43-F	Kjeldahl Nitrogen - dissolved	TKN-D	mg-N/L			< 0.1			< 0.1	J	Q	0.21			0.15			0.10			0.18
43-F	Kjeldahl Nitrogen - total	TKN-T	mg-N/L			< 0.1			0.12	J	Q	< 0.1			0.12			< 0.1			< 0.1
43-F	Nitrate Nitrogen	NO_3	mg-N/L			< 0.1			< 0.1	UJ	h	< 0.1			< 0.1			< 0.1			< 0.1
43-F	Nitrite Nitrogen	NO_2	mg-N/L			< 0.1			< 0.1	UJ	h	< 0.1			< 0.1			< 0.1			< 0.1
43-F	Oil & Grease	O&G	mg/L			< 2			< 2			< 2			< 2			< 2			< 2
43-F	Organic Carbon - total	TOC	mg/L			< 1			< 1			< 1			< 1			< 1			< 1
43-F	Orthophosphate - dissolved	OP-D	mg-P/L			< 0.03			< 0.03	UJ	h	< 0.03			< 0.03			< 0.03			< 0.03
43-F	Orthophosphate - total	OP-T	mg-P/L			< 0.03			< 0.03	J	h	0.03			< 0.03			< 0.03			< 0.03
43-F	pH (field)	pH	pH Units			7.7			7.1			5.4			5.6			5.6			5.5
43-F	Phosphorus - dissolved	Phos-D	mg-P/L			< 0.03			< 0.03			< 0.03			< 0.03			< 0.03			< 0.03
43-F	Phosphorus - total	Phos-T	mg-P/L			< 0.03			< 0.03			< 0.03			< 0.03			< 0.03			< 0.03
43-F	Temperature (field)	Temp	°C			7.4			5.3			10.1			7.4			15.1			19.2
43-F	Total Dissolved Solids	TDS	mg/L			< 1			2			< 1			< 1			230			< 1
43-F	Total Nitrogen (calculated)	TN	mg-N/L			< 0.1			0.12			< 0.1			0.12			< 0.1			< 0.1
43-F	Total Suspended Solids	TSS	mg/L			4			< 1			< 1			< 1			< 1			< 1
43-F	Turbidity (field)	Turb	NTU			< 0.1			< 0.1			0.07			0.07			0.05			0.05

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Phase II Water Quality Data, 2003

Treatment Designation	PARAMETER	ABV.	UNITS	Run 7			Run 8			Run 9			Run 10			Run 11			Run 12		
				Data Qualifier	Reason	Result =	Data Qualifier	Reason	Result =	Data Qualifier	Reason	Result =	Data Qualifier	Reason	Result =	Data Qualifier	Reason	Result =	Data Qualifier	Reason	Result =
44-S	Run #	Run #	-			7			8			9			10			11			12
44-S	Date of Collection	Date - Col	-			3/15/2003			3/15/2003			5/6/2003			5/6/2003			5/20/2003			5/27/2003
44-S	Date Run (Day 1)	Date - Run				3/16/2003			3/18/2003			5/6/2003			5/8/2003			5/20/2003			5/27/2003
44-S	Lab Name	Lab	-			Soil/Tox			Soil/Tox			Soil/Tox			Soil/Tox			Soil/Tox			Soil/Tox
44-S	Water Source	Source	-			HPLC			HPLC			HPLC			HPLC			HPLC			HPLC
44-S	QC Type	QC-T	-			Process Blk			Process Blk			Process Blk			Process Blk			Process Blk			Process Blk
44-S	QC Reference (dup of sample)	QC-R	-			Runs 7&8			Runs 7&8			Runs 9&10			Runs 9&10			Run 11			Run 12
44-S	Unit (Sed., Filter, Mechanized, etc.)	Unit				N/A			N/A			N/A			N/A			N/A			N/A
44-S	Chemical	Chem.	-			N/A			N/A			N/A			N/A			N/A			N/A
44-S	Chemical Dose	Chem. Dose	mg/L			N/A			N/A			N/A			N/A			N/A			N/A
44-S	Sedimentation Time	Sed. Time	hours			N/A			N/A			N/A			N/A			N/A			N/A
44-S	Filter Media	Media	-			N/A			N/A			N/A			N/A			N/A			N/A
44-S	Filter Loading (6 hour or "fast")	Loading	-			N/A			N/A			N/A			N/A			N/A			N/A
44-S	Filter Outlet (free or submerged)	Filt. Outlet	-			N/A			N/A			N/A			N/A			N/A			N/A
44-S	Pilot Plant ID #	Plant ID#	-			07-44-S			08-44-S			09-44-S			10-44-S			11-44-S			12-44-S
44-S	Laboratory Log #	Lab #	-			T303046-22			T303052-16			T-305008-05			T-305011-04			T-305028-13			T-305040-06
44-S	Alkalinity - total	Alk-T	mg-$CaCO_3$/L			< 1			< 1			< 1			< 1			< 1			2
44-S	Aluminum - acid soluble	Al-AS	µg/L			< 25			< 25			< 25			< 25			< 25			< 25
44-S	Aluminum - dissolved	Al-D	µg/L			< 25			< 25			< 25			< 25			< 25			< 25
44-S	Aluminum - total	Al-T	µg/L			< 25			< 25			< 25			< 25			< 25			< 25
44-S	Ammonia	NH_4	mg-N/L			< 0.1			< 0.1			< 0.1			< 0.1			< 0.1			< 0.1
44-S	Conductivity (field)	EC	µmhos/cm			< 1			< 1			< 1			< 1			1			< 1
44-S	Iron - dissolved	Fe-D	µg/L			< 25			< 25			< 25			< 25			< 25			< 25
44-S	Iron - total	Fe-T	µg/L			< 25			< 25			< 25			< 25			< 25			< 25
44-S	Kjeldahl Nitrogen - dissolved	TKN-D	mg-N/L			< 0.1			< 0.1			0.14			0.23			0.14			< 0.1
44-S	Kjeldahl Nitrogen - total	TKN-T	mg-N/L			< 0.1			< 0.1			< 0.1			0.13			0.13			0.11
44-S	Nitrate Nitrogen	NO_3	mg-N/L			< 0.1			< 0.1	UJ	h	< 0.1			< 0.1			< 0.1			< 0.1
44-S	Nitrite Nitrogen	NO_2	mg-N/L			< 0.1			< 0.1	UJ	h	< 0.1			< 0.1			< 0.1			< 0.1
44-S	Oil & Grease	O&G	mg/L			< 2			< 2			< 2			< 2			< 2			< 2
44-S	Organic Carbon - total	TOC	mg/L			< 1			< 1			< 1			< 1			< 1			< 1
44-S	Orthophosphate - dissolved	OP-D	mg-P/L			< 0.03			< 0.03	UJ	h	< 0.03			< 0.03			< 0.03			< 0.03
44-S	Orthophosphate - total	OP-T	mg-P/L			< 0.03			< 0.03	UJ	h	< 0.03			< 0.03			< 0.03			< 0.03
44-S	pH (field)	pH	pH Units			7.7			6.7			5.7			5.9			5.6			5.5
44-S	Phosphorus - dissolved	Phos-D	mg-P/L			< 0.03			< 0.03			< 0.03			< 0.03			< 0.03			< 0.03
44-S	Phosphorus - total	Phos-T	mg-P/L			< 0.03			< 0.03			< 0.03			< 0.03			< 0.03			< 0.03
44-S	Temperature (field)	Temp	°C			7.4			5.2			9.6			7.3			14.7			19.1
44-S	Total Dissolved Solids	TDS	mg/L			< 1			8			< 1			< 1			< 1			< 1
44-S	Total Nitrogen (calculated)	TN	mg-N/L			< 0.1			< 0.1			< 0.1			0.13			0.13			0.11
44-S	Total Suspended Solids	TSS	mg/L			< 1			2			< 1			< 1			2			< 1
44-S	Turbidity (field)	Turb	NTU			< 0.1			< 0.1			0.33			0.06			0.05			0.05

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Phase II Water Quality Data, 2003

Treatment Designation	PARAMETER	ABV.	UNITS	Run 7	Run 8	Run 9	Run 10	Run 11	Run 12
				Data Qualifier Reason = Result	Data Qualifier Reason = Result	Data Qualifier Reason = Result	Data Qualifier Reason = Result	Data Qualifier Reason = Result	Data Qualifier Reason = Result
44-F	Run #	Run #	-	7	8	9	10	11	12
44-F	Date of Collection	Date - Col	-	3/15/2003	3/15/2003	5/6/2003	5/6/2003	5/20/2003	5/27/2003
44-F	Date Run (Day 1)	Date - Run		3/16/2003	3/18/2003	5/6/2003	5/8/2003	5/20/2003	5/27/2003
44-F	Lab Name	Lab	-	Soil/Tox	Soil/Tox	Soil/Tox	Soil/Tox	Soil/Tox	Soil/Tox
44-F	Water Source	Source	-	HPLC	HPLC	HPLC	HPLC	HPLC	HPLC
44-F	QC Type	QC-T	-	Equip Blk	Equip Blk	Equip Blk	Equip Blk	Equip Blk	Equip Blk
44-F	QC Reference (dup of sample)	QC-R	-	Runs 7&8	Runs 7&8	Runs 9&10	Runs 9&10	Run 11	Run 12
44-F	Unit (Sed., Filter, Mechanized, etc.)	Unit		N/A	N/A	N/A	N/A	N/A	N/A
44-F	Chemical	Chem.	-	N/A	N/A	N/A	N/A	N/A	N/A
44-F	Chemical Dose	Chem. Dose	mg/L	N/A	N/A	N/A	N/A	N/A	N/A
44-F	Sedimentation Time	Sed. Time	hours	N/A	N/A	N/A	N/A	N/A	N/A
44-F	Filter Media	Media	-	N/A	N/A	N/A	N/A	N/A	N/A
44-F	Filter Loading (6 hour or "fast")	Loading	-	N/A	N/A	N/A	N/A	N/A	N/A
44-F	Filter Outlet (free or submerged)	Filt. Outlet	-	N/A	N/A	N/A	N/A	N/A	N/A
44-F	Pilot Plant ID #	Plant ID#	-	07-44-F	08-44-F	09-44-F	10-44-F	11-44-F	12-44-F
44-F	Laboratory Log #	Lab #	-	T303046-09	T303052-17	T-305008-26	T-305011-03	T-305028-12	T-305040-09
44-F	Alkalinity - total	Alk-T	mg-$CaCO_3$/L	2	< 1	1	< 1	< 1	3
44-F	Aluminum - acid soluble	Al-AS	µg/L	< 25	< 25	< 25	< 25	< 25	28
44-F	Aluminum - dissolved	Al-D	µg/L	< 25	< 25	< 25	< 25	< 25	< 25
44-F	Aluminum - total	Al-T	µg/L	< 25	38	< 25	93	< 25	< 25
44-F	Ammonia	NH_4	mg-N/L	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
44-F	Conductivity (field)	EC	µmhos/cm	< 1	< 1	< 1	< 1	1	< 1
44-F	Iron - dissolved	Fe-D	µg/L	< 25	< 25	< 25	< 25	< 25	< 25
44-F	Iron - total	Fe-T	µg/L	< 25	< 25	< 25	< 25	< 25	< 25
44-F	Kjeldahl Nitrogen - dissolved	TKN-D	mg-N/L	0.12	0.14	0.18	0.22	0.12	0.12
44-F	Kjeldahl Nitrogen - total	TKN-T	mg-N/L	< 0.1	< 0.1	< 0.1	0.16	0.12	< 0.1
44-F	Nitrate Nitrogen	NO_3	mg-N/L	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
44-F	Nitrite Nitrogen	NO_2	mg-N/L	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
44-F	Oil & Grease	O&G	mg/L	< 2	< 2	< 2	< 2	< 2	< 2
44-F	Organic Carbon - total	TOC	mg/L	< 1	< 1	< 1	< 1	< 1	< 1
44-F	Orthophosphate - dissolved	OP-D	mg-P/L	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03
44-F	Orthophosphate - total	OP-T	mg-P/L	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03
44-F	pH (field)	pH	pH Units	7.9	6.2	5.6	5.6	5.6	5.8
44-F	Phosphorus - dissolved	Phos-D	mg-P/L	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03
44-F	Phosphorus - total	Phos-T	mg-P/L	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03
44-F	Temperature (field)	Temp	°C	7.3	5.4	10.5	7.2	14.9	17.8
44-F	Total Dissolved Solids	TDS	mg/L	< 1	6	< 1	< 1	< 1	< 1
44-F	Total Nitrogen (calculated)	TN	mg-N/L	< 0.1	< 0.1	< 0.1	0.16	0.12	< 0.1
44-F	Total Suspended Solids	TSS	mg/L	2	< 1	< 1	< 1	< 1	< 1
44-F	Turbidity (field)	Turb	NTU	0.4	0.7	0.08	0.09	0.10	0.10

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Phase II Water Quality Data, 2003

Treatment Designation	PARAMETER	ABV.	UNITS	Run 7 Data Qualifier	Run 7 Result Reason =	Run 8 Data Qualifier	Run 8 Result Reason =	Run 9 Data Qualifier	Run 9 Result Reason =	Run 10 Data Qualifier	Run 10 Result Reason =	Run 11 Data Qualifier	Run 11 Result Reason =	Run 12 Data Qualifier	Run 12 Result Reason =
PE Blanks	Run #	Run #	-		7		8		9		10		11		12
PE Blanks	Date of Collection	Date - Col	-		3/15/2003		3/15/2003		5/6/2003		5/6/2003		5/20/2003		5/27/2003
PE Blanks	Date Run (Day 1)	Date - Run			3/16/2003		3/18/2003		5/6/2003		5/8/2003		5/20/2003		5/27/2003
PE Blanks	Lab Name	Lab	-		Soil/Tox		Soil/Tox		Soil/Tox		Soil/Tox		Soil/Tox		Soil/Tox
PE Blanks	Water Source	Source	-		ERA		-		-		-		-		-
PE Blanks	QC Type	QC-T	-		PE Blank		-		-		-		-		-
PE Blanks	QC Reference (dup of sample)	QC-R	-		Runs 7&8		-		-		-		-		-
PE Blanks	Unit (Sed., Filter, Mechanized, etc.)	Unit			N/A		N/A		N/A		N/A		N/A		N/A
PE Blanks	Chemical	Chem.	-		N/A		N/A		N/A		N/A		N/A		N/A
PE Blanks	Chemical Dose	Chem. Dose	mg/L		N/A		N/A		N/A		N/A		N/A		N/A
PE Blanks	Sedimentation Time	Sed. Time	hours		N/A		N/A		N/A		N/A		N/A		N/A
PE Blanks	Filter Media	Media	-		N/A		N/A		N/A		N/A		N/A		N/A
PE Blanks	Filter Loading (6 hour or "fast")	Loading	-		N/A		N/A		N/A		N/A		N/A		N/A
PE Blanks	Filter Outlet (free or submerged)	Filt. Outlet	-		N/A		N/A		N/A		N/A		N/A		N/A
PE Blanks	Pilot Plant ID #	Plant ID#	-		07-20-S		No Sample		09-45-S		No Sample		No Sample		No Sample
PE Blanks	Laboratory Log #	Lab #	-		T303046-24				T-305008-28						
PE Blanks	Alkalinity - total	Alk-T	mg-$CaCO_3$/L												
PE Blanks	Aluminum - acid soluble	Al-AS	µg/L												
PE Blanks	Aluminum - dissolved	Al-D	µg/L												
PE Blanks	Aluminum - total	Al-T	µg/L												
PE Blanks	Ammonia	NH_4	mg-N/L												
PE Blanks	Conductivity (field)	EC	µmhos/cm												
PE Blanks	Iron - dissolved	Fe-D	µg/L		< 25				< 25						
PE Blanks	Iron - total	Fe-T	µg/L		< 25				< 25						
PE Blanks	Kjeldahl Nitrogen - dissolved	TKN-D	mg-N/L		< 0.1				< 0.1						
PE Blanks	Kjeldahl Nitrogen - total	TKN-T	mg-N/L		< 0.1				< 0.1						
PE Blanks	Nitrate Nitrogen	NO_3	mg-N/L												
PE Blanks	Nitrite Nitrogen	NO_2	mg-N/L												
PE Blanks	Oil & Grease	O&G	mg/L												
PE Blanks	Organic Carbon - total	TOC	mg/L		< 1				< 1						
PE Blanks	Orthophosphate - dissolved	OP-D	mg-P/L												
PE Blanks	Orthophosphate - total	OP-T	mg-P/L												
PE Blanks	pH (field)	pH	pH Units												
PE Blanks	Phosphorus - dissolved	Phos-D	mg-P/L		< 0.03				< 0.03						
PE Blanks	Phosphorus - total	Phos-T	mg-P/L		< 0.03				< 0.03						
PE Blanks	Temperature (field)	Temp	°C												
PE Blanks	Total Dissolved Solids	TDS	mg/L												
PE Blanks	Total Nitrogen (calculated)	TN	mg-N/L												
PE Blanks	Total Suspended Solids	TSS	mg/L												
PE Blanks	Turbidity (field)	Turb	NTU												

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Phase II Water Quality Data, 2003

Treatment Designation	PARAMETER	ABV.	UNITS	Run 7	Run 8	Run 9	Run 10	Run 11	Run 12
				Data Qualifier Reason = Result	Data Qualifier Reason = Result	Data Qualifier Reason = Result	Data Qualifier Reason = Result	Data Qualifier Reason = Result	Data Qualifier Reason = Result
PE Samples	Run #	Run #	-	7	8	9	10	11	12
PE Samples	Date of Collection	Date - Col	-	3/15/2003	3/15/2003	5/6/2003	5/6/2003	5/20/2003	5/27/2003
PE Samples	Date Run (Day 1)	Date - Run		3/16/2003	3/18/2003	5/6/2003	5/8/2003	5/20/2003	5/27/2003
PE Samples	Lab Name	Lab	-	Soil/Tox	Soil/Tox	Soil/Tox	Soil/Tox	Soil/Tox	Soil/Tox
PE Samples	Water Source	Source	-	ERA	-	-	-	-	-
PE Samples	QC Type	QC-T	-	PE Sample	-	-	-	-	-
PE Samples	QC Reference (dup of sample)	QC-R	-	Runs 7&8	-	-	-	-	-
PE Samples	Unit (Sed., Filter, Mechanized, etc.)	Unit		N/A	N/A	N/A	N/A	N/A	N/A
PE Samples	Chemical	Chem.	-	N/A	N/A	N/A	N/A	N/A	N/A
PE Samples	Chemical Dose	Chem. Dose	mg/L	N/A	N/A	N/A	N/A	N/A	N/A
PE Samples	Sedimentation Time	Sed. Time	hours	N/A	N/A	N/A	N/A	N/A	N/A
PE Samples	Filter Media	Media	-	N/A	N/A	N/A	N/A	N/A	N/A
PE Samples	Filter Loading (6 hour or "fast")	Loading	-	N/A	N/A	N/A	N/A	N/A	N/A
PE Samples	Filter Outlet (free or submerged)	Filt. Outlet	-	N/A	N/A	N/A	N/A	N/A	N/A
PE Samples	Pilot Plant ID #	Plant ID#	-	07-20-F	No Sample	09-45-F	No Sample	No Sample	No Sample
PE Samples	Laboratory Log #	Lab #	-	T303046-23		T-305008-27			
PE Samples	Alkalinity - total	Alk-T	mg-$CaCO_3$/L						
PE Samples	Aluminum - acid soluble	Al-AS	µg/L						
PE Samples	Aluminum - dissolved	Al-D	µg/L						
PE Samples	Aluminum - total	Al-T	µg/L						
PE Samples	Ammonia	NH_4	mg-N/L						
PE Samples	Conductivity (field)	EC	µmhos/cm						
PE Samples	Iron - dissolved	Fe-D	µg/L	440		470			
PE Samples	Iron - total	Fe-T	µg/L	450		460			
PE Samples	Kjeldahl Nitrogen - dissolved	TKN-D	mg-N/L	0.42		0.55			
PE Samples	Kjeldahl Nitrogen - total	TKN-T	mg-N/L	0.49		0.55			
PE Samples	Nitrate Nitrogen	NO_3	mg-N/L						
PE Samples	Nitrite Nitrogen	NO_2	mg-N/L						
PE Samples	Oil & Grease	O&G	mg/L						
PE Samples	Organic Carbon - total	TOC	mg/L	19		19			
PE Samples	Orthophosphate - dissolved	OP-D	mg-P/L						
PE Samples	Orthophosphate - total	OP-T	mg-P/L						
PE Samples	pH (field)	pH	pH Units						
PE Samples	Phosphorus - dissolved	Phos-D	mg-P/L	0.10		0.10			
PE Samples	Phosphorus - total	Phos-T	mg-P/L	0.10		0.11			
PE Samples	Temperature (field)	Temp	°C						
PE Samples	Total Dissolved Solids	TDS	mg/L						
PE Samples	Total Nitrogen (calculated)	TN	mg-N/L						
PE Samples	Total Suspended Solids	TSS	mg/L						
PE Samples	Turbidity (field)	Turb	NTU						

Caltrans Lake Tahoe Small-Scale Storm Water Treatment Pilot Plant

Phase II Water Quality Data, 2003

Treatment Designation	PARAMETER	ABV.	UNITS	Run 7	Run 8	Run 9	Run 10	Run 11	Run 12
				Data Qualifier Reason = Result	Data Qualifier Reason = Result	Data Qualifier Reason = Result	Data Qualifier Reason = Result	Data Qualifier Reason = Result	Data Qualifier Reason = Result
Other	Run #	Run #	-	7	8	9	10	11	12
Other	Date of Collection	Date - Col	-	3/15/2003	3/15/2003	5/6/2003	5/6/2003	5/20/2003	5/27/2003
Other	Date Run (Day 1)	Date - Run		3/16/2003	N/A	5/6/2003	5/8/2003	5/20/2003	5/27/2003
Other	Lab Name	Lab	-	Soil/Tox	Soil/Tox	Soil/Tox	Soil/Tox	Soil/Tox	Soil/Tox
Other	Water Source	Source	-	-	Influent	-	-	-	-
Other	QC Type	QC-T	-	-	3 days before	-	-	-	-
Other	QC Reference (dup of sample)	QC-R	-	-	use	-	-	-	-
Other	Unit (Sed., Filter, Mechanized, etc.)	Unit		N/A	N/A	N/A	N/A	N/A	N/A
Other	Chemical	Chem.	-	N/A	N/A	N/A	N/A	N/A	N/A
Other	Chemical Dose	Chem. Dose	mg/L	N/A	N/A	N/A	N/A	N/A	N/A
Other	Sedimentation Time	Sed. Time	hours	N/A	N/A	N/A	N/A	N/A	N/A
Other	Filter Media	Media	-	N/A	N/A	N/A	N/A	N/A	N/A
Other	Filter Loading (6 hour or "fast")	Loading	-	N/A	N/A	N/A	N/A	N/A	N/A
Other	Filter Outlet (free or submerged)	Filt. Outlet	-	N/A	N/A	N/A	N/A	N/A	N/A
Other	Pilot Plant ID #	Plant ID#	-	No Sample	08-001	No Sample	No Sample	No Sample	No Sample
Other	Laboratory Log #	Lab #	-		T303046-01				
Other	Alkalinity - total	Alk-T	mg-$CaCO_3$/L		27				
Other	Aluminum - acid soluble	Al-AS	µg/L		260				
Other	Aluminum - dissolved	Al-D	µg/L		< 25				
Other	Aluminum - total	Al-T	µg/L		6200				
Other	Ammonia	NH_4	mg-N/L		< 0.1				
Other	Conductivity (field)	EC	µmhos/cm		255				
Other	Iron - dissolved	Fe-D	µg/L		< 25				
Other	Iron - total	Fe-T	µg/L		5800				
Other	Kjeldahl Nitrogen - dissolved	TKN-D	mg-N/L		0.41				
Other	Kjeldahl Nitrogen - total	TKN-T	mg-N/L		1.0				
Other	Nitrate Nitrogen	NO_3	mg-N/L		0.10				
Other	Nitrite Nitrogen	NO_2	mg-N/L		< 0.1				
Other	Oil & Grease	O&G	mg/L		3				
Other	Organic Carbon - total	TOC	mg/L		10				
Other	Orthophosphate - dissolved	OP-D	mg-P/L		0.04				
Other	Orthophosphate - total	OP-T	mg-P/L		0.19				
Other	pH (field)	pH	pH Units		7.8				
Other	Phosphorus - dissolved	Phos-D	mg-P/L		0.08				
Other	Phosphorus - total	Phos-T	mg-P/L		0.28				
Other	Temperature (field)	Temp	°C		4.2				
Other	Total Dissolved Solids	TDS	mg/L		150				
Other	Total Nitrogen (calculated)	TN	mg-N/L		1.1				
Other	Total Suspended Solids	TSS	mg/L		146				
Other	Turbidity (field)	Turb	NTU		201				

Caltrans Lake Tahoe Small-Scale Storm Water Treatment Pilot Plant

Phase II Water Quality Data, 2003

Treatment Designation	PARAMETER	ABV.	UNITS	Run 7 Data Qualifier	Run 7 Reason	Run 7 =	Run 7 Result	Run 8 Data Qualifier	Run 8 Reason	Run 8 =	Run 8 Result	Run 9 Data Qualifier	Run 9 Reason	Run 9 =	Run 9 Result	Run 10 Data Qualifier	Run 10 Reason	Run 10 =	Run 10 Result	Run 11 Data Qualifier	Run 11 Reason	Run 11 =	Run 11 Result	Run 12 Data Qualifier	Run 12 Reason	Run 12 =	Run 12 Result
24hr Sed Avg	Run #	Run #	-				7				8				9				10				11				12
24hr Sed Avg	Date of Collection	Date - Col	-				3/15/2003				3/15/2003				5/6/2003				5/6/2003				5/20/2003				5/27/2003
24hr Sed Avg	Date Run (Day 1)	Date - Run					3/16/2003				3/18/2003				5/6/2003				5/8/2003				5/20/2003				5/27/2003
24hr Sed Avg	Lab Name	Lab	-				Soil/Tox				Soil/Tox				Soil/Tox				Soil/Tox				Soil/Tox				Soil/Tox
24hr Sed Avg	Water Source	Source	-				HY89+Boxes				Ski Run				HY89+Boxes				Ski Run				On-site				Snow Yard
24hr Sed Avg	QC Type	QC-T	-				Calc				Calc				Calc				Calc				Calc				Calc
24hr Sed Avg	QC Reference (dup of sample)	QC-R	-				36-S & 38-S				36-S & 38-S				36-S & 38-S				36-S & 38-S				36-S & 38-S				36-S & 38-S
24hr Sed Avg	Unit (Sed., Filter, Mechanized, etc.)	Unit					Sed.				Sed.				Sed.				Sed.				Sed.				Sed.
24hr Sed Avg	Chemical	Chem.	-				None				None				None				None				None				None
24hr Sed Avg	Chemical Dose	Chem. Dose	mg/L				None				None				None				None				None				None
24hr Sed Avg	Sedimentation Time	Sed. Time	hours				24				24				24				24				24				24
24hr Sed Avg	Filter Media	Media	-				N/A				N/A				N/A				N/A				N/A				N/A
24hr Sed Avg	Filter Loading (6 hour or "fast")	Loading	-				N/A				N/A				N/A				N/A				N/A				N/A
24hr Sed Avg	Filter Outlet (free or submerged)	Filt. Outlet	-				N/A				N/A				N/A				N/A				N/A				N/A
24hr Sed Avg	Pilot Plant ID #	Plant ID#	-				N/A				N/A				N/A				N/A				N/A				N/A
24hr Sed Avg	Laboratory Log #	Lab #	-				N/A				N/A				N/A				N/A				N/A				N/A
24hr Sed Avg	Alkalinity - total	Alk-T	mg-$CaCO_3$/L				30				28	U	x		38				63				25				31
24hr Sed Avg	Aluminum - acid soluble	Al-AS	µg/L				546				225				105			<	25				470				445
24hr Sed Avg	Aluminum - dissolved	Al-D	µg/L			<	25			<	25			<	25			<	25			<	25				41
24hr Sed Avg	Aluminum - total	Al-T	µg/L				6350				2800				1125				110				13500	J	m		19500
24hr Sed Avg	Ammonia	NH_4	mg-N/L			<	0.1			<	0.1				0.11			<	0.1			<	0.1			<	0.1
24hr Sed Avg	Conductivity (field)	EC	µmhos/cm				566				237				285				284				1395				262
24hr Sed Avg	Iron - dissolved	Fe-D	µg/L			<	25				103				35			<	25				54				
24hr Sed Avg	Iron - total	Fe-T	µg/L				5600				3000				1950				220	J	m		15000				17500
24hr Sed Avg	Kjeldahl Nitrogen - dissolved	TKN-D	mg-N/L	U	x		0.38				0.20	UJ	d,x		0.34	U	x		0.22			<	0.1	UJ	f,x		0.27
24hr Sed Avg	Kjeldahl Nitrogen - total	TKN-T	mg-N/L				0.79				0.57	J	d		0.66	U	x		0.23	U	x		0.55				0.75
24hr Sed Avg	Nitrate Nitrogen	NO_3	mg-N/L			<	0.1			<	0.1			<	0.1				0.33	DD		<	0.1	R	f		0.24
24hr Sed Avg	Nitrite Nitrogen	NO_2	mg-N/L			<	0.1			<	0.1			<	0.1			<	0.1			<	0.1			<	0.1
24hr Sed Avg	Oil & Grease	O&G	mg/L				4			<	2			<	2			<	2				4			<	2
24hr Sed Avg	Organic Carbon - total	TOC	mg/L	J	m		12				13				13				5.5				22	R	f		26
24hr Sed Avg	Orthophosphate - dissolved	OP-D	mg-P/L				0.03			<	0.03			<	0.03			<	0.03				0.04			<	0.03
24hr Sed Avg	Orthophosphate - total	OP-T	mg-P/L				0.20				0.09			<	0.03			<	0.03				0.25				0.21
24hr Sed Avg	pH (field)	pH	pH Units				7.0				7.2				7.0				7.9				7.4				7.3
24hr Sed Avg	Phosphorus - dissolved	Phos-D	mg-P/L			<	0.03				0.06			<	0.03				0.09				0.06			<	0.03
24hr Sed Avg	Phosphorus - total	Phos-T	mg-P/L				0.33				0.22				0.13				0.08				0.74				0.75
24hr Sed Avg	Temperature (field)	Temp	°C				3.0				5.9				7.4				7.5				13.2				16.8
24hr Sed Avg	Total Dissolved Solids	TDS	mg/L				319				152				163				175	U	x		796				254
24hr Sed Avg	Total Nitrogen (calculated)	TN	mg-N/L				0.79				0.57				0.66				0.56	DD			0.55				0.99
24hr Sed Avg	Total Suspended Solids	TSS	mg/L				136				48				26			<	1				254				128
24hr Sed Avg	Turbidity (field)	Turb	NTU				198				109				47				5.1				393				486

Appendix B

Summary Tables

Appendix B Summary Tables

Table B-1. Comparison of Day 1 to Day 2 Influent Quality (Runs 7 through 9)

Parameter	Units	Run 7			Run 8			Run 9		
		Day 1	Day 2	RPD	Day 1	Day 2	RPD	Day 1	Day 2	RPD
Alkalinity - total	mg-$CaCO_3$/L	30	30	0.0	28	28	0.0	37	37	0.0
Aluminum - acid soluble	µg/L	478	422	12.4	280	320	13.3	135	150	10.5
Aluminum - dissolved	µg/L	26.5	29	9.0	<25	<25	0.0	<25	<25	0.0
Aluminum - total	µg/L	12000	12000	0.0	6850	6200	10.0	1555	640	83.4
Ammonia	mg-N/L	<0.1	<0.1	0.0	<0.1	<0.1	0.0	0.15	0.11	30.8
Conductivity (field)	µmhos/cm	603	593	1.7	237.5	253	6.3	313	283	10.1
Iron - dissolved	µg/L	48	40	18.2	<25	<25	0.0	125	100	22.2
Iron - total	µg/L	10500	11000	4.7	6400	6500	1.6	2850	2600	9.2
Kjeldahl Nitrogen - dissolved	mg-N/L	0.395	0.35	12.1	0.51	0.70	31.4	0.885	0.64	32.1
Kjeldahl Nitrogen - total	mg-N/L	1.4	1.4	0.0	0.97	1.0	3.0	0.7	0.75	6.9
Nitrate Nitrogen	mg-N/L	<0.1	<0.1	0.0	<0.1	<0.1	0.0	<0.1	<0.1	0.0
Nitrite Nitrogen	mg-N/L	<0.1	<0.1	0.0	<0.1	<0.1	0.0	<0.1	<0.1	0.0
Oil & Grease	mg/L	10.5	11	4.7	5.5	5	9.5	<2	<2	0.0
Organic Carbon - total	mg/L	11.5	14	19.6	12	9	28.6	13.5	12	11.8
Orthophosphate - dissolved	mg-P/L	<0.03	<0.03	0.0	<0.03	<0.03	0.0	<0.03	<0.03	0.0
Orthophosphate - total	mg-P/L	0.445	0.35	23.9	0.21	0.21	0.0	0.07	<0.03	80.0
pH (field)	pH Units	8.05	7.4	8.4	6.8	6.9	1.5	6.9	7.1	2.9
Phosphorus - dissolved	mg-P/L	<0.03	<0.03	0.0	0.055	0.05	9.5	<0.03	0.03	0.0
Phosphorus - total	mg-P/L	0.555	0.75	29.9	0.495	0.52	4.9	0.175	0.18	2.8
Total Dissolved Solids	mg/L	312	314	0.6	148	142	4.1	158	162	2.5
Total Nitrogen (calculated)	mg-N/L	1.4	1.4	0.0	0.97	1.0	3.0	0.7	0.75	6.9
Total Suspended Solids	mg/L	364	380	4.3	178	170	4.6	63	56	11.8
Turbidity (field)	NTU	430.5	332	25.8	199	192	3.6	60.75	65.1	6.9

Highlighted values represent influent samples that differed by more than fifty percent.

Table B-2. Comparison of Day 1 to Day 2 Influent Quality (Runs 10 through 12)

Parameter	Units	Run 10			Run 11			Run 12		
		Day 1	Day 2	RPD	Day 1	Day 2	RPD	Day 1	Day 2	RPD
Alkalinity - total	mg-$CaCO_3$/L	62	61	1.6	24	24	0.0	30	30	0.0
Aluminum - acid soluble	µg/L	<25	<25	0.0	700	730	4.2	620	400	43.1
Aluminum - dissolved	µg/L	<25	<25	0.0	<25	<25	0.0	<25	<25	0.0
Aluminum - total	µg/L	355	320	10.4	19000	17000	11.1	20500	21000	2.4
Ammonia	mg-N/L	<0.1	<0.1	0.0	<0.1	<0.1	0.0	<0.1	<0.1	0.0
Conductivity (field)	µmhos/cm	277	277	0.0	1423	1404	1.3	257	264	2.7
Iron - dissolved	µg/L	40	38	5.1	<25	<25	0.0	<25	<25	0.0
Iron - total	µg/L	785	660	17.3	20500	21000	2.4	20000	21000	4.9
Kjeldahl Nitrogen - dissolved	mg-N/L	0.255	0.32	22.6	<0.1	<0.1	0.0	0.12	0.26	73.7
Kjeldahl Nitrogen - total	mg-N/L	0.255	0.26	1.9	0.935	1.0	6.7	0.97	0.99	2.6
Nitrate Nitrogen	mg-N/L	<0.1	0.11	9.5	0.1	<0.1	0.0	<0.1	<0.1	0.0
Nitrite Nitrogen	mg-N/L	<0.1	<0.1	0.0	0.1	<0.1	0.0	<0.1	<0.1	0.0
Oil & Grease	mg/L	<2	<2	0.0	10.5	13	21.3	<2	<2	0.0
Organic Carbon - total	mg/L	5.25	5.5	4.7	13	20	42.2	18	12	40.0
Orthophosphate - dissolved	mg-P/L	<0.03	<0.03	0.0	0.045	0.04	11.8	<0.03	<0.03	0.0
Orthophosphate - total	mg-P/L	<0.03	<0.03	0.0	0.67	0.68	1.5	0.24	0.25	6.2
pH (field)	pH Units	7.9	7.9	0.0	7.4	7.5	1.3	7.3	7.3	0.0
Phosphorus - dissolved	mg-P/L	0.0525	0.05	4.9	0.06	0.06	0.0	<0.03	<0.03	0.0
Phosphorus - total	mg-P/L	0.1	0.07	35.3	0.775	1.1	34.7	0.85	0.88	3.5
Total Dissolved Solids	mg/L	174	168	3.5	784	776	1.0	270	264	2.2
Total Nitrogen (calculated)	mg-N/L	0.255	0.37	36.8	0.935	1.0	6.7	0.97	0.99	2.6
Total Suspended Solids	mg/L	23	22	4.4	466	508	8.6	236	208	12.6
Turbidity (field)	NTU	15.25	15.1	1.0	560	548	2.2	577	574	0.5

Highlighted values represent influent samples that differed by more than fifty percent.

Table B-3. Project Blank Sample Results (Runs 7 through 9)

Parameter	Units	7-43-S	7-43-F	7-44-S	7-44-F	8-43-S	8-43-F	8-44-S	8-44-F	9-43-S	9-43-F	9-44-S	9-44-F
		Btl	Proc	Proc	EQ	Btl	Proc	Proc	EQ	Btl	Proc	Proc	EQ
Alkalinity - total	mg-$CaCO_3$/L	<1	<1	<1	2	<1	<1	<1	<1	<1	29	<1	1
Aluminum - acid soluble	µg/L	<25	<25	<25	<25	<25	<25	<25	<25	<25	<25	<25	<25
Aluminum - dissolved	µg/L	<25	<25	<25	<25	<25	<25	<25	<25	<25	<25	<25	<25
Aluminum - total	µg/L	<25	<25	<25	<25	<25	<25	<25	38	<25	<25	<25	<25
Ammonia	mg-N/L	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Conductivity (field)	µmhos/cm	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Iron - dissolved	µg/L	<25	<25	<25	<25	<25	<25	<25	<25	<25	<25	<25	<25
Iron - total	µg/L	<25	<25	<25	<25	<25	<25	<25	<25	<25	<25	<25	<25
Kjeldahl Nitrogen - dissolved	mg-N/L	<0.1	<0.1	<0.1	0.12	<0.1	<0.1	<0.1	0.14	<0.1	0.21	0.14	0.18
Kjeldahl Nitrogen - total	mg-N/L	<0.1	<0.1	<0.1	<0.1	<0.1	0.12	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Nitrate Nitrogen	mg-N/L	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Nitrite Nitrogen	mg-N/L	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Oil & Grease	mg/L	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
Organic Carbon - total	mg/L	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Orthophosphate - dissolved	mg-P/L	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03
Orthophosphate - total	mg-P/L	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	0.03	<0.03	<0.03
pH (field)	pH Units	8.2	7.7	7.7	7.9	6.9	7.1	6.7	6.2	5.6	5.4	5.7	5.6
Phosphorus - dissolved	mg-P/L	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03
Phosphorus - total	mg-P/L	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03
Temperature (field)	mg/L	6.7	7.4	7.4	7.3	3.1	5.3	5.2	5.4	9.1	10.1	9.6	10.5
Total Dissolved Solids	mg-N/L	<1	<1	<1	<1	8	2	8	6	<1	<1	<1	<1
Total Nitrogen (calculated)	mg/L	<0.1	<0.1	<0.1	<0.1	<0.1	0.12	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Total Suspended Solids	NTU	<1	4	<1	2	<1	<1	2	<1	<1	<1	<1	<1
Turbidity (field)	mg-$CaCO_3$/L	<0.1	<0.1	<0.1	0.4	<0.1	<0.1	<0.1	0.7	0.07	0.07	0.33	0.08

EQ = equipment blank, Btl = bottle blank, Proc= process blank, Dis = Dissolved.
Highlighted values received extra scrutiny often leading to qualified results.

Table B-4. Project Blank Sample Results (Runs 10 through 12)

Parameter	Units	10-43-S	10-43-F	10-44-S	10-44-F	11-43-S	11-43-F	11-44-S	11-44-F	12-43-S	12-43-F	12-44-S	12-44-F
		Btl	Proc	Proc	EQ	Btl	Proc	Proc	EQ	Btl	Proc	Proc	EQ
Alkalinity - total	mg-$CaCO_3$/L	<1	<1	<1	<1	<1	<1	<1	<1	2	2	2	3
Aluminum - acid soluble	µg/L	<25	<25	<25	<25	<25	<25	<25	<25	<25	<25	<25	28
Aluminum - dissolved	µg/L	<25	<25	<25	<25	<25	<25	<25	<25	<25	<25	<25	<25
Aluminum - total	µg/L	<25	<25	<25	93	<25	<25	<25	<25	<25	<25	<25	<25
Ammonia	mg-N/L	<0.1	0.12	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Conductivity (field)	µmhos/cm	1	1	<1	<1	<1	1	1	1	<1	<1	<1	<1
Iron - dissolved	µg/L	<25	<25	<25	<25	<25	<25	<25	<25	<25	<25	<25	<25
Iron - total	µg/L	<25	<25	<25	<25	<25	<25	<25	<25	<25	<25	<25	<25
Kjeldahl Nitrogen - dissolved	mg-N/L	0.11	0.15	0.23	0.22	<0.1	0.1	0.14	0.12	<0.1	0.18	<0.1	0.12
Kjeldahl Nitrogen - total	mg-N/L	0.18	0.12	0.13	0.16	0.13	<0.1	0.13	0.12	<0.1	<0.1	0.11	<0.1
Nitrate Nitrogen	mg-N/L	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Nitrite Nitrogen	mg-N/L	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Oil & Grease	mg/L	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
Organic Carbon - total	mg/L	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Orthophosphate - dissolved	mg-P/L	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03
Orthophosphate - total	mg-P/L	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03
pH (field)	pH Units	5.7	5.6	5.9	5.6	5.7	5.6	5.6	5.6	5.8	5.5	5.5	5.8
Phosphorus - dissolved	mg-P/L	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03
Phosphorus - total	mg-P/L	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03
Temperature (field)	mg/L	7.8	7.4	7.3	7.2	14.9	15.1	14.7	14.9	19	19.2	19.1	17.8
Total Dissolved Solids	mg-N/L	<1	<1	<1	<1	<1	230	<1	<1	<1	<1	<1	<1
Total Nitrogen (calculated)	mg/L	0.18	0.12	0.13	0.16	0.13	<0.1	0.13	0.12	<0.1	<0.1	0.11	<0.1
Total Suspended Solids	NTU	<1	<1	<1	<1	<1	<1	2	<1	<1	<1	<1	<1
Turbidity (field)	mg-$CaCO_3$/L	0.07	0.07	0.06	0.09	0.07	0.05	0.05	0.10	0.06	0.05	0.05	0.10

EQ = equipment blank, Btl = bottle blank, Proc= process blank, Dis = Dissolved.
Highlighted values received extra scrutiny often leading to qualified results.

Table B-5. Project Field Duplicate Sample Results (Run 7)

Parameter	Units	Run 7			Run 7			Run 7		
		7- I- 01	7- 41 - S	RPD	7- 41- F	7-PFF	RPD	7- 42- S	7-30-S	RPD
Alkalinity - total	mg-$CaCO_3$/L	31	29	6.7	24	23	4.3	30	29	3.4
Aluminum - acid soluble	µg/L	456	500	9.2	64	46	32.7	309	317	2.6
Aluminum - dissolved	µg/L	26	27	3.8	33	39	16.7	25	25	0.0
Aluminum - total	µg/L	13000	11000	16.7	43	41	4.8	5200	5200	0.0
Ammonia	mg-N/L	0.1	0.1	0.0	0.1	0.1	0.0	0.1	0.1	0.0
Conductivity (field)	µmhos/cm	593	612	3.2	627	611	2.6	554	581	4.8
Iron - dissolved	µg/L	48	48	0.0	25	25	0.0	38	37	2.7
Iron - total	µg/L	11000	10000	9.5	25	25	0.0	4500	4800	6.5
Kjeldahl Nitrogen - dissolved	mg-N/L	0.57	0.22	88.6	0.24	0.25	4.1	0.25	0.18	32.6
Kjeldahl Nitrogen - total	mg-N/L	1.4	1.4	0.0	0.22	0.26	16.7	0.69	0.53	26.2
Nitrate Nitrogen	mg-N/L	0.1	0.1	0.0	0.10	0.11	9.5	0.1	0.1	0.0
Nitrite Nitrogen	mg-N/L	0.1	0.1	0.0	0.1	0.1	0.0	0.1	0.1	0.0
Oil & Grease	mg/L	11	10	9.5	2	2	0.0	3	4	28.6
Organic Carbon - total	mg/L	12	11	8.7	6	6	0.0	1	10	163.6
Orthophosphate - dissolved	mg-P/L	0.03	0.03	0.0	0.03	0.03	0.0	0.03	0.03	0.0
Orthophosphate - total	mg-P/L	0.46	0.43	6.7	0.03	0.03	0.0	0.14	0.15	6.9
pH (field)	pH Units	8.1	8.0	1.2	7.0	7.2	2.8	7.0	7.1	1.4
Phosphorus - dissolved	mg-P/L	0.03	0.03	0.0	0.03	0.03	0.0	0.03	0.03	0.0
Phosphorus - total	mg-P/L	0.57	0.54	5.4	0.03	0.03	0.0	0.24	0.27	11.8
Temperature (field)	mg/L	2.9	3.0	3.4	4.6	5.0	8.3	2.8	2.2	24.0
Total Dissolved Solids	mg-N/L	304	320	5.1	298	304	2.0	312	312	0.0
Total Nitrogen (calculated)	mg/L	1.4	0.69	67.9	0.32	0.37	7.3	0.32	0.53	49.4
Total Suspended Solids	NTU	364	364	0.0	6	1	142.9	110	108	1.8
Turbidity (field)	mg-$CaCO_3$/L	445	416	6.7	0.8	0.8	0.0	162	162	0.0

Highlighted values indicate a relative percent difference exceeds acceptance level (50).

Table B-6. Project Field Duplicate Sample Results (Run 8)

Parameter	Units	Run 8			Run 8			Run 8		
		8- I- 01	8- 41- S	RPD	8- 41- F	8- 35- F	RPD	8- 42- S	8- PCA	RPD
Alkalinity - total	mg-CaCO3/L	28	28	0.0	36	33	8.7	13	14	7.4
Aluminum - acid soluble	µg/L	300	260	14.3	160	190	17.1	25	28	11.3
Aluminum - dissolved	µg/L	25	34	30.5	25	25	0.0	25	25	0.0
Aluminum - total	µg/L	6800	6900	1.5	3900	3800	2.6	28	36	25.0
Ammonia	mg-N/L	0.1	0.1	0.0	0.1	0.1	0.0	0.1	0.1	0.0
Conductivity (field)	µmhos/cm	233	242	3.8	298	319	6.8	303	294	3.0
Iron - dissolved	µg/L	25	36	36.1	25	25	0.0	25	25	0.0
Iron - total	µg/L	6500	6300	3.1	3300	3700	11.4	25	25	0.0
Kjeldahl Nitrogen - dissolved	mg-N/L	0.44	0.58	27.5	0.62	0.51	19.5	0.21	0.12	54.5
Kjeldahl Nitrogen - total	mg-N/L	0.97	0.97	0.0	0.62	0.62	0.0	0.15	0.18	18.2
Nitrate Nitrogen	mg-N/L	0.1	0.1	0.0	0.1	0.1	0.0	0.1	0.1	0.0
Nitrite Nitrogen	mg-N/L	0.1	0.1	0.0	0.1	0.1	0.0	0.1	0.1	0.0
Oil & Grease	mg/L	6	5	18.2	2	2	0.0	2	2	0.0
Organic Carbon - total	mg/L	9	15	50.0	12	10	18.2	2	2	0.0
Orthophosphate - dissolved	mg-P/L	0.03	0.03	0.0	0.04	0.04	0.0	0.03	0.03	0.0
Orthophosphate - total	mg-P/L	0.21	0.21	0.0	0.16	0.17	6.1	0.03	0.03	0.0
pH (field)	pH Units	6.9	6.7	2.9	6.9	7.1	2.9	6.7	6.6	1.5
Phosphorus - dissolved	mg-P/L	0.07	0.04	54.5	0.08	0.07	13.3	0.03	0.03	0.0
Phosphorus - total	mg-P/L	0.52	0.47	10.1	0.34	0.28	19.4	0.03	0.03	0.0
Temperature (field)	mg/L	6.6	6.6	0.0	4.9	4.7	4.2	6.1	6.2	1.6
Total Dissolved Solids	mg-N/L	144	152	5.4	178	184	3.3	148	152	2.7
Total Nitrogen (calculated)	mg/L	0.97	0.97	0.0	0.62	0.62	0.0	0.15	0.18	18.2
Total Suspended Solids	NTU	184	172	6.7	72	70	2.8	1	1	0.0
Turbidity (field)	mg-CaCO3/L	204	194	5.0	117	117	0.0	0.3	0.3	0.0

Highlighted values indicate a relative percent difference exceeds acceptance level (50).

Table B-7. Project Field Duplicate Sample Results (Run 9)

Parameter	Units	Run 9			Run 9			Run 9		
		9- I- 01	9- 41- S	RPD	9- 41- F	9- PFF	RPD	9- 42- S	9- 30- S	RPD
Alkalinity - total	mg-$CaCO_3$/L	37	37	0.0	20	20	0.0	37	39	5.3
Aluminum - acid soluble	µg/L	130	140	7.4	60	92	42.1	96	130	30.1
Aluminum - dissolved	µg/L	25	25	0.0	25	25	0.0	27	25	7.7
Aluminum - total	µg/L	810	2300	95.8	64	83	25.9	630	470	29.1
Ammonia	mg-N/L	0.15	0.15	0.0	0.11	0.13	16.7	0.1	0.14	33.3
Conductivity (field)	µmhos/cm	323	303	6.4	328	327	0.3	291	284	2.4
Iron - dissolved	µg/L	130	120	8.0	25	120	131.0	26	36	32.3
Iron - total	µg/L	2800	2900	3.5	25	25	0.0	920	1400	41.4
Kjeldahl Nitrogen - dissolved	mg-N/L	0.47	1.3	93.8	0.42	0.50	17.4	0.36	0.37	2.7
Kjeldahl Nitrogen - total	mg-N/L	0.70	0.70	0.0	0.25	0.23	8.3	0.57	0.59	3.4
Nitrate Nitrogen	mg-N/L	0.1	0.1	0.0	0.1	0.1	0.0	0.10	0.1	0.0
Nitrite Nitrogen	mg-N/L	0.1	0.1	0.0	0.1	0.1	0.0	0.1	0.1	0.0
Oil & Grease	mg/L	2	2	0.0	2	2	0.0	2	2	0.0
Organic Carbon - total	mg/L	12	15	22.2	5	5	0.0	10	10	0.0
Orthophosphate - dissolved	mg-P/L	0.03	0.03	0.0	0.03	0.03	0.0	0.03	0.03	0.0
Orthophosphate - total	mg-P/L	0.08	0.06	28.6	0.03	0.03	0.0	0.03	0.03	0.0
pH (field)	pH Units	6.9	6.9	0.0	6.5	6.5	0.0	6.8	7.1	4.3
Phosphorus - dissolved	mg-P/L	0.03	0.03	0.0	0.03	0.03	0.0	0.03	0.03	0.0
Phosphorus - total	mg-P/L	0.18	0.17	5.7	0.03	0.03	0.0	0.03	0.12	120.0
Temperature (field)	mg/L	9.9	9.4	5.2	8.4	8.4	0.0	7.5	7.7	2.6
Total Dissolved Solids	mg-N/L	154	162	5.1	160	156	2.5	152	152	0.0
Total Nitrogen (calculated)	mg/L	0.70	0.70	0.0	0.25	0.23	8.3	0.67	0.59	12.7
Total Suspended Solids	NTU	68	58	15.9	1	1	0.0	28	40	35.3
Turbidity (field)	mg-$CaCO_3$/L	60.4	61.1	1.2	0.34	0.35	2.9	40.1	46.8	15.4

Highlighted values indicate a relative percent difference exceeds acceptance level (50).

Table B-8. Project Field Duplicate Sample Results (Run 10)

Parameter	Units	Run 10			Run 10			Run 10		
		10- I- 01	10- 41- S	RPD	10- 41- F	10- PA	RPD	10- 42- S	10- 38- S	RPD
Alkalinity - total	mg-$CaCO_3$/L	61	63	3.2	41	40	2.5	59	61	3.3
Aluminum - acid soluble	µg/L	25	33	27.6	120	110	8.7	25	25	0.0
Aluminum - dissolved	µg/L	25	25	0.0	25	25	0.0	25	25	0.0
Aluminum - total	µg/L	320	390	19.7	140	140	0.0	70	80	13.3
Ammonia	mg-N/L	0.1	0.1	0.0	0.1	0.1	0.0	0.1	0.1	0.0
Conductivity (field)	µmhos/cm	278	276	0.7	321	327	1.9	277	280	1.1
Iron - dissolved	µg/L	40	40	0.0	25	25	0.0	33	35	5.9
Iron - total	µg/L	770	800	3.8	25	25	0.0	220	220	0.0
Kjeldahl Nitrogen - dissolved	mg-N/L	0.32	0.19	51.0	0.23	0.27	16.0	0.31	0.21	38.5
Kjeldahl Nitrogen - total	mg-N/L	0.25	0.26	3.9	0.24	0.20	18.2	0.19	0.24	23.3
Nitrate Nitrogen	mg-N/L	0.1	0.1	0.0	0.1	0.1	0.0	0.72	0.61	16.5
Nitrite Nitrogen	mg-N/L	0.1	0.1	0.0	0.1	0.1	0.0	0.1	0.1	0.0
Oil & Grease	mg/L	2	2	0.0	2	2	0.0	2	2	0.0
Organic Carbon - total	mg/L	5.3	5.2	1.9	2.4	2.5	4.1	5.2	5.3	1.9
Orthophosphate - dissolved	mg-P/L	0.03	0.03	0.0	0.03	0.03	0.0	0.03	0.03	0.0
Orthophosphate - total	mg-P/L	0.03	0.03	0.0	0.03	0.03	0.0	0.03	0.03	0.0
pH (field)	pH Units	7.9	7.9	0.0	6.8	6.8	0.0	7.8	7.9	1.3
Phosphorus - dissolved	mg-P/L	0.03	0.09	100.0	0.03	0.03	0.0	0.08	0.11	31.6
Phosphorus - total	mg-P/L	0.10	0.10	0.0	0.05	0.03	50.0	0.10	0.07	35.3
Temperature (field)	mg/L	8.1	8.1	0.0	8.2	8.1	1.2	7.5	7.3	2.7
Total Dissolved Solids	mg-N/L	168	180	6.9	200	194	3.0	180	182	1.1
Total Nitrogen (calculated)	mg/L	0.25	0.26	3.9	0.24	0.20	18.2	0.91	0.85	6.8
Total Suspended Solids	NTU	24	22	8.7	1	1	0.0	1	1	0.0
Turbidity (field)	mg-$CaCO_3$/L	15.0	15.5	3.3	0.34	0.32	6.1	5.6	5.2	7.4

Highlighted values indicate a relative percent difference exceeds acceptance level (50).

Table B-9. Project Field Duplicate Sample Results (Run 11)

PARAMETER	UNITS	Run 11			Run 11			Run 11		
		11- I- 01	11- 41- S	RPD	11- 41- F	11- PFF	RPD	11- 42- S	11-30-S	RPD
Alkalinity - total	mg-CaCO3/L	24	24	0.0	14	15	6.9	22	23	2.2
Aluminum - acid soluble	µg/L	480	920	62.9	25	25	0.0	25	25	0.0
Aluminum - dissolved	µg/L	25	25	0.0	25	25	0.0	25	25	0.0
Aluminum - total	µg/L	17000	21000	21.1	39	35	10.8	220	240	4.4
Ammonia	mg-N/L	0.1	0.1	0.0	0.1	0.1	0.0	0.1	0.1	0.0
Conductivity (field)	µmhos/cm	1413	1433	1.4	1425	1431	0.4	1400	1399	0.0
Iron - dissolved	µg/L	25	25	0.0	25	25	0.0	25	25	0.0
Iron - total	µg/L	21000	20000	4.9	30	29	3.4	170	170	0.0
Kjeldahl Nitrogen - dissolved	mg-N/L	0.1	0.15	40.0	0.22	0.21	4.7	0.16	0.14	6.7
Kjeldahl Nitrogen - total	mg-N/L	0.93	0.94	1.1	0.24	0.21	13.3	0.1	0.1	0.0
Nitrate Nitrogen	mg-N/L	0.1	0.1	0.0	0.1	0.1	0.0	0.1	0.1	0.0
Nitrite Nitrogen	mg-N/L	0.1	0.1	0.0	0.1	0.1	0.0	0.1	0.1	0.0
Oil & Grease	mg/L	13	8	47.6	2	2	0.0	2	2	0.0
Organic Carbon - total	mg/L	16	10	46.2	1	1	0.0	2	2	0.0
Orthophosphate - dissolved	mg-P/L	0.05	0.04	22.2	0.03	0.03	0.0	0.04	0.04	0.0
Orthophosphate - total	mg-P/L	0.64	0.70	9.0	0.03	0.03	0.0	0.04	0.04	0.0
pH (field)	pH Units	7.4	7.4	0.0	6.7	6.7	0.0	7.3	7.3	0.0
Phosphorus - dissolved	mg-P/L	0.06	0.06	0.0	0.03	0.03	0.0	0.06	0.05	9.1
Phosphorus - total	mg-P/L	0.87	0.68	24.5	0.03	0.03	0.0	0.06	0.07	7.7
Temperature (field)	mg/L	11.1	11.2	0.9	11.1	10.9	1.8	12.9	12.9	0.0
Total Dissolved Solids	mg-N/L	784	784	0.0	708	714	0.8	694	710	1.1
Total Nitrogen (calculated)	mg/L	0.93	0.94	1.1	0.24	0.21	13.3	0.1	0.1	0.0
Total Suspended Solids	NTU	440	492	11.2	1	4	120.0	4	6	20.0
Turbidity (field)	mg-CaCO3/L	554	566	2.1	0.85	0.85	0.0	4.4	4.3	1.2

Highlighted values indicate a relative percent difference exceeds acceptance level (50).

Table B-10. Project Field Duplicate Sample Results (Run 12)

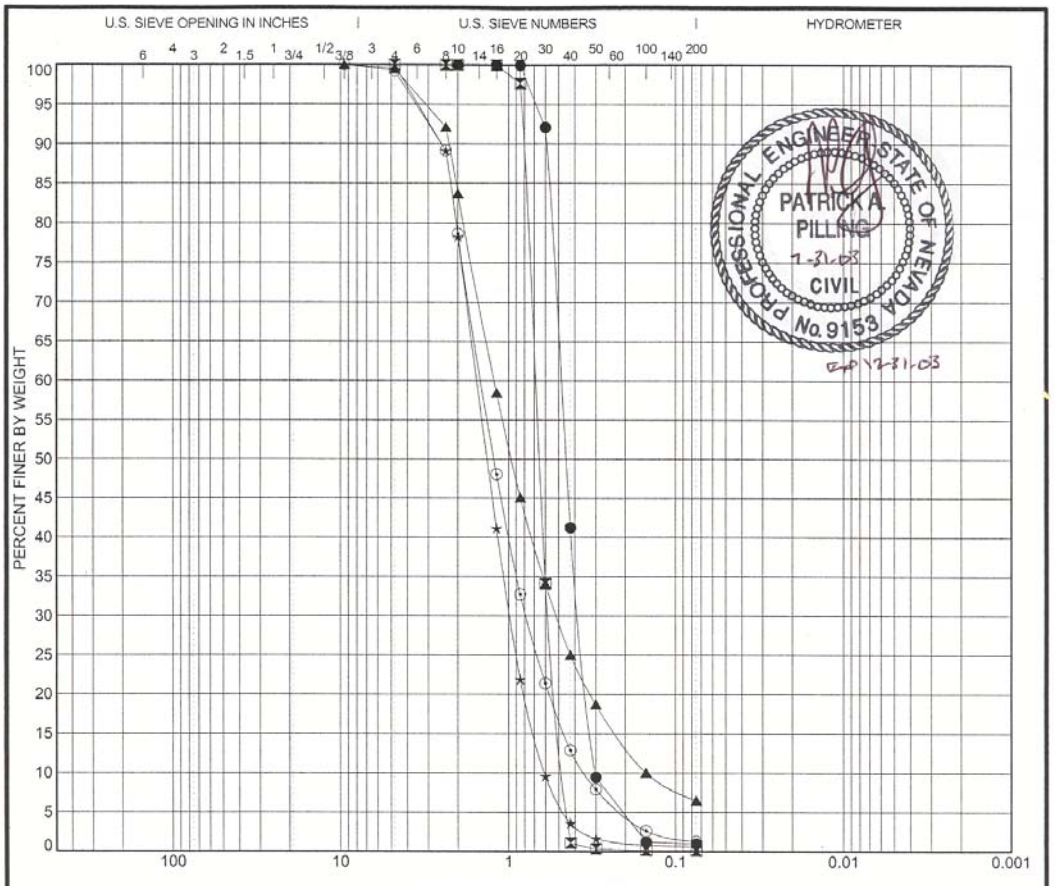
Parameter	Units	Run 12			Run 12			Run 12		
		12- I- 01	11- 41- S	RPD	12- 41- F	12- PA	RPD	12- 42- S	12- 38- S	RPD
Alkalinity - total	mg-$CaCO_3$/L	30	30	0.0	18	18	0.0	29	30	3.4
Aluminum - acid soluble	µg/L	640	600	6.5	83	47	55.4	510	450	12.5
Aluminum - dissolved	µg/L	25	25	0.0	51	94	59.3	25	25	0.0
Aluminum - total	µg/L	23000	18000	24.4	130	110	16.7	17000	18000	5.7
Ammonia	mg-N/L	0.1	0.1	0.0	0.1	0.1	0.0	0.1	0.1	0.0
Conductivity (field)	µmhos/cm	258	256	0.8	295	298	1.0	261	261	0.0
Iron - dissolved	µg/L	25	25	0.0	25	25	0.0	25	25	0.0
Iron - total	µg/L	20000	20000	0.0	100	97	3.0	18000	18000	0.0
Kjeldahl Nitrogen - dissolved	mg-N/L	0.19	0.1	62.1	0.38	0.45	16.9	0.42	0.25	50.7
Kjeldahl Nitrogen - total	mg-N/L	0.98	0.95	3.1	0.18	0.27	40.0	0.78	0.76	2.6
Nitrate Nitrogen	mg-N/L	0.1	0.1	0.0	0.1	0.1	0.0	0.1	0.42	123.1
Nitrite Nitrogen	mg-N/L	0.1	0.1	0.0	0.1	0.1	0.0	0.1	0.1	0.0
Oil & Grease	mg/L	2	2	0.0	2	2	0.0	2	2	0.0
Organic Carbon - total	mg/L	22	14	44.4	2	2	0.0	1	29	186.7
Orthophosphate - dissolved	mg-P/L	0.03	0.03	0.0	0.03	0.03	0.0	0.03	0.03	0.0
Orthophosphate - total	mg-P/L	0.22	0.25	12.8	0.03	0.03	0.0	0.20	0.20	0.0
pH (field)	pH Units	7.3	7.3	0.0	6.6	6.6	0.0	7.3	7.3	0.0
Phosphorus - dissolved	mg-P/L	0.03	0.03	0.0	0.03	0.03	0.0	0.03	0.03	0.0
Phosphorus - total	mg-P/L	0.82	0.88	7.1	0.03	0.03	0.0	0.69	0.71	2.9
Temperature (field)	mg/L	15.0	15.6	3.9	14.6	14.6	0.0	16.6	16.8	1.2
Total Dissolved Solids	mg-N/L	264	276	4.4	134	142	5.8	268	244	9.4
Total Nitrogen (calculated)	mg/L	0.98	0.95	3.1	0.18	0.27	40.0	0.78	1.18	40.8
Total Suspended Solids	NTU	220	252	13.6	1	1	0.0	124	124	0.0
Turbidity (field)	mg-$CaCO_3$/L	573	581	1.4	3.5	3.2	9.0	489	476	2.7

Highlighted values indicate a relative percent difference exceeds acceptance level (50).

Appendix C

Filter Media Sieve Analyses

Appendix C Filter Media Sieve Analyses



Specimen Identification		LL	PL	PI	Cc	Cu
● Activated Alumina	Filter Medium				0.97	1.60
⊠ Lapis Sand	Filter Medium				1.02	1.48
▲ Limestone	Filter Medium				1.46	8.20
★ Shale	Filter Medium				1.02	2.54
⊙ Washed Limestone	Filter Medium				1.21	4.18

Specimen Identification	D100	D60	D30	D10	MC %	%Gravel	%Sand	%Silt	%Clay
● Activated Alumina	2	0.483	0.376	0.302	13.6	0.0	99.0	1.0	
⊠ Lapis Sand	4.75	0.692	0.575	0.466	0.1	0.0	99.9	0.1	
▲ Limestone	9.5	1.217	0.513	0.148	0.7	0.5	93.0	6.5	
★ Shale	9.5	1.542	0.975	0.607	1.4	0.0	99.4	0.6	
⊙ Washed Limestone	9.5	1.45	0.781	0.347	1.2	0.7	98.0	1.3	

US GRAIN SIZE2 0262021.GPJ US LAB.GDT 7/31/2003

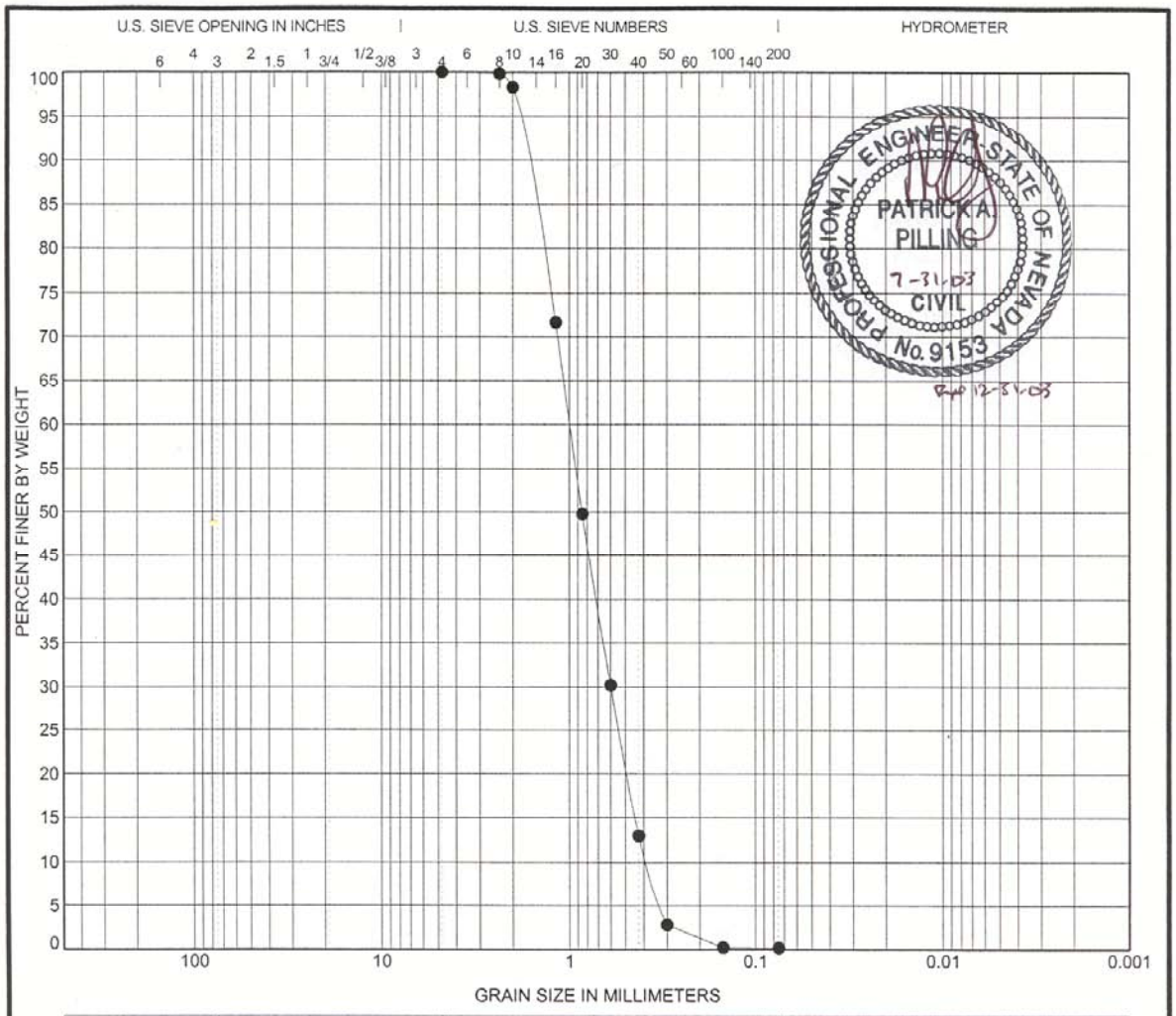
Black Eagle Consulting, Inc.
1345 Capital Blvd., Suite A
Reno, Nevada 89502-7140
Telephone: (775) 359-6600
Fax: (775) 359-7766

GRAIN SIZE DISTRIBUTION

Project: Eco:Logic Testing as Ordered

Location: Reno, Nevada

Project Number: 0262-02-1 Plate Number: 1a



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Specimen Identification		LL	PL	PI	Cc	Cu
● Wollastonite	Filter Medium				0.94	2.58

Specimen Identification	D100	D60	D30	D10	MC %	%Gravel	%Sand	%Silt	%Clay
● Wollastonite	4.75	0.991	0.597	0.384	0.0	0.0	99.8	0.2	

US GRAIN SIZE2 026\021.GPJ US LAB.GDT 7/31/2003

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GRAIN SIZE DISTRIBUTION

Project: Eco:Logic Testing as Ordered

Location: Reno, Nevada

Project Number: 0262-02-1 Plate Number: 1b

Appendix D

Quality Control Summary Reports

Appendix D Quality Control Summary Reports

RUN 7

DATE: May 20, 2003 **SITE:** Caltrans: Lake Tahoe Pilot Project

SUBJECT: **Caltrans: Lake Tahoe Pilot Project – Run 7**
ToxScan Report No.: T-303046

A limited data review (including electronic validation by Caltrans Laboratory EDD Processing Tool) was performed by the Sacramento Project Chemistry Group on ToxScan Report No.: T-303046 in support of the Caltrans: Lake Tahoe Pilot Project. The report contains analytical data for 36 aqueous samples (including three field duplicate pairs, one performance evaluation sample, two field blanks, one bottle blank, one equipment blank, and one performance evaluation blank). Sample IDs are listed in Table 1. Samples **07-PFF/07-41-F**, **07-30-S/07-42-S**, and **07-I-01/07-41-S** represent field duplicate pairs. The samples were collected between March 16 and 18, 2003 and submitted to ToxScan, Inc. in Watsonville, California for analysis of Nitrate (EPA Method 300.0), Nitrite (EPA Method 300.0), Oil and Grease (EPA Method 1664), Total Alkalinity (EPA Method 310.1), Total and Dissolved Aluminum (EPA Method 200.8), Acid Soluble Aluminum (EPA Method 440/5-86-008), Total Ammonia (SM-4500), Total and Dissolved Iron (EPA Method 200.7), Total and Dissolved Ortho-Phosphate (EPA Method 365.2), Total and Dissolved Kjeldahl Nitrogen (EPA Method 351.3), Total Organic Carbon (EPA Method 415.1), Total and Dissolved Phosphorous (EPA Method 365.2), Total Dissolved Solids (TDS; EPA Method 160.1), and Total Suspended Solids (TSS; EPA Method 160.2).

The data were reviewed in accordance with analytical methods outlined in EPA SW-846 and Analysis of Water and Wastewater. The following presents an overview of the limited data validation. The areas reviewed are listed below. A check mark (3) indicates an area of review in which all data were acceptable without qualification; a crossed circle (⊗) signifies areas where issues raised during validation impacted data quality and/or usability.

- ✓ Data Completeness
- ✓ Holding Times
- ⊗ Blanks
- ✓ Laboratory Control Samples
- ⊗ Matrix Spike/Matrix Spike Duplicates
- ✓ Laboratory Duplicates
- ⊗ Field Duplicates
- ⊗ Total/Dissolved Comparison
- ✓ Performance Evaluation Sample
- ✓ Analyte Quantification

Data Completeness

The sample analyses were performed as requested on the chain-of-custody records with the exceptions summarized in the following table.

Analyte	Analysis Requested	Analysis Performed
Total Kjeldahl Nitrogen	EPA Method 351.3	EPA Method 351.1
Dissolved Kjeldahl Nitrogen	EPA Method 351.3	EPA Method 351.1

Sample **07-42-S** was incorrectly identified by ToxScan as **07-40-S** throughout the data package and in the electronic data. Corrections were made to the electronic data.

Sample **07-I-01** was incorrectly identified by Soil Control Lab as **07-I-O** throughout the data package and in the electronic data. Corrections were made to the electronic data.

Holding Time and Preservation
The samples were analyzed within the holding times specified in the Caltrans: Guidance Manual: Storm Water Monitoring Protocols.

Blanks
The blanks with target analyte contamination are listed in the following table.

Blank	Contaminant	Concentration
07-43-F (Field Blank)	Total Suspended Solids	4 mg/L
07-44-F (Equipment Blank)	Total Suspended Solids	2 mg/L
	Dissolved Kjeldahl Nitrogen	0.12 mg/L
	Total Alkalinity	1.6 mg/L
Laboratory Refrigerator Blank	Total Organic Carbon	15 mg/L

A sample result was qualified as anomalous (U) if instrument concentration of the sample was within five-times the instrument concentration of an associated blank. The qualified data are summarized in the following table. Although Total Organic Carbon was reported in the refrigerator blank, all other blanks were free of Total Organic Carbon. In addition, the performance evaluation sample, which was submitted with the project samples, was not impacted by the contamination. Consequently, the project sample data were not qualified based on the refrigerator blank contamination.

Analyte	Qualifier	Samples Qualified	Concentration (mg/L)
Total Suspended Solids	U	**07-34-F**	2
		07-37-F	2
		07-38-F	2
		07-41-F	6
		07-CFS	10
		07-PA	10
Dissolved Kjeldahl Nitrogen	U	**07-30-S**	0.18
		07-31-F	0.43
		07-32-F	0.20
		07-33-S	0.18
		07-34-F	0.28
		07-34-S	0.35
		07-35-F	0.50
		07-35-S	0.34
		07-36-F	0.47
		07-36-S	0.27
		07-37-F	0.16
		07-38-F	0.30
		07-40-F	0.49

Analyte	Qualifier	Samples Qualified	Concentration (mg/L)
Dissolved Kjeldahl Nitrogen (cont.)	U	**07-41-F** **07-41-S** **07-42-S** **07-CCA** **07-CFS** **07-CPSF** **07-I-01** **07-I-03** **07-PA** **07-PCA** **07-PFF**	0.24 0.22 0.25 0.22 0.57 0.25 0.57 0.35 0.25 0.17 0.25
Total Organic Carbon	U	**None**	NA

Laboratory Control Samples
The LCS recoveries for all analytes were within acceptance limits.

Matrix Spike and Matrix Spike Duplicate
The following table lists the project samples utilized for the Matrix Spike/Matrix Spike Duplicate analyses. The recoveries and relative percent differences were within the acceptance criteria for all analytes except Total Organic Carbon.

Analyte	Project Sample(s) Utilized
Acid Soluble, Dissolved, and Total Aluminum, Dissolved and Total Iron, Dissolved and Total Kjeldahl Nitrogen, Total Organic Carbon, Nitrate, Nitrite, Dissolved and Total Ortho-Phosphate, and Dissolved and Total Phosphorus	**07-32-F, 07-PA, and 07-36-S**

It should be noted that a low average percent recovery was reported for the Total Organic Carbon matrix spike analysis of sample **07-36-S**. Consequently, the reported results for Total Organic Carbon in samples **07-30-S, 07-31-F**, **07-36-F**, **07-36-S**, **07-37-F**, **07-38-S**, **07-38-F**, **07-40-F**, **07-42-S**, **07-CPSF**, and **07-I-03** should be considered estimated and may be biased low.

Laboratory Duplicates
The following table lists the project samples utilized for the Laboratory Duplicate analyses.

Analyte	Project Sample(s) Utilized
Total Alkalinity, Acid Soluble, Dissolved, and Total Aluminum, Dissolved and Total Iron, Dissolved and Total Kjeldahl Nitrogen, Oil and Grease, Total Organic Carbon, Nitrate, Nitrite, Dissolved and Total Ortho-Phosphate, and Dissolved and Total Phosphorus	**07-32-F, 07-PA, and 07-36-S**
Total Dissolved Solids and Total Suspended Solids	**07-PA and 07-42-S**

The relative percent differences for all analytes were within the acceptance criteria.

Field Duplicates

The field duplicate pairs, **07-PFF/07-41-F**, **07-30-S/07-42-S**, and **07-I-01/07-41-S**, demonstrated acceptable field and laboratory precision for all analytes except those listed in the following table.

Analyte	Primary Sample Result	Field Duplicate Result	Qualifier
Field Duplicate Pair 07-PFF/07-41-F			
Total Suspended Solids	1.0 mg/L	6.0 mg/L	**J**[1]
Field Duplicate Pair 07-30-S/07-42-S			
Total Organic Carbon	9.6 mg/L	1.0 mg/L	**J**[1]
Field Duplicate Pair 07-I-01/07-41-S			
Dissolved Kjeldahl Nitrogen	0.57 mg/L	0.22 mg/L	**J**[1]

Note:
1. The relative percent difference between the primary and duplicate results was greater than 50%, therefore, the data were considered estimated (J).

Total/Dissolved Comparison

For all samples, a comparison of the total and dissolved data demonstrated acceptable results for all analytes except those listed in the following table.

Sample	Analyte	Total Result	Dissolved Result	Qualifier
07-37-F	Aluminum	400 µg/L	470 µg/L	**J**[1]
07-40-F	Aluminum	510 µg/L	590 µg/L	**J**[1]
07-38-F	Kjeldahl Nitrogen	0.15 mg/L	0.30 mg/L	**J**[2]
07-CFS	Kjeldahl Nitrogen	0.22 mg/L	0.57 mg/L	**R**[3]
07-33-F	Kjeldahl Nitrogen	0.51 mg/L	0.62 mg/L	**J**[2]

Notes:
1. The dissolved concentration exceeded the acid soluble aluminum concentration by more than the reporting limit or 10%. The data were estimated (J).
2. The dissolved concentration exceeded the total concentration by more than the reporting limit or 10%. The data were estimated (J).
3. The dissolved concentration exceeded the total concentration by more than 2-times the reporting limit or 20%. The data were rejected.

Performance Evaluation Sample

Samples **07-20-F** and **07-20-S** were submitted to the laboratory as a double blind performance evaluation sample and an associated reference blank. The results for all certified analytes are summarized below.

Sample 07-20-F				
Analyte	**Certified Value**	**Laboratory Result**	**Acceptance Criteria**	**Pass/Fail**
Total Organic Carbon	20.0 mg/L	19 mg/L	17.3 – 22.8 mg/L	Pass
Dissolved Kjeldahl Nitrogen	0.50 mg/L	0.42 mg/L	0.385 – 0.620 mg/L	Pass
Total Kjeldahl Nitrogen	0.50 mg/L	0.49 mg/L	0.385 – 0.620 mg/L	Pass
Dissolved Phosphorous	0.10 mg/L	0.1 mg/L	0.0831 – 0.117 mg/L	Pass
Total Phosphorous	0.10 mg/L	0.1 mg/L	0.0831 – 0.117 mg/L	Pass
Dissolved Iron	0.500 mg/L	0.440 µg/L	0.437 – 0.565 mg/L	Pass

Sample 07-20-F				
Analyte	**Certified Value**	**Laboratory Result**	**Acceptance Criteria**	**Pass/Fail**
Total Iron	0.500 mg/L	0.450 m/L	0.437 – 0.565 mg/L	Pass
Sample 07-20-S				
Analyte	**Certified Value**	**Laboratory Result**	**Acceptance Criteria**	**Pass/Fail**
Total Organic Carbon	--	ND	--	--
Dissolved Kjeldahl Nitrogen	--	ND	--	--
Total Kjeldahl Nitrogen	--	ND	--	--
Dissolved Phosphorous	--	ND	--	--
Total Phosphorous	--	ND	--	--
Dissolved Iron	--	ND	--	--
Total Iron	--	ND	--	--

Acceptable results were obtained for all seven certified analytes.

Analyte Quantification
The project-specific reporting limits were met for all analytes.

Table 1. Lake Tahoe Pilot Project Samples

Sample	Lab Sample Number	Date Sampled
Project Samples		
07-41-S (Field Duplicate of 07-I-01)	T303046-02	03/16/2003
07-I-01	T303046-03	03/16/2003
07-35-F	T303046-04	03/17/2003
07-CCA	T303046-05	03/17/2003
07-33-S	T303046-06	03/17/2003
07-35-S	T303046-07	03/17/2003
07-34-F	T303046-08	03/17/2003
07-32-F	T303046-10	03/17/2003
07-34-S	T303046-11	03/17/2003
07-41-F (Field Duplicate of 07-PFF)	T303046-12	03/17/2003
07-PCA	T303046-13	03/17/2003
07-PFF	T303046-14	03/17/2003
07-33-F	T303046-15	03/17/2003
07-CFS	T303046-17	03/17/2003
07-PA	T303046-18	03/17/2003
07-CPSF	T303046-20	03/17/2003
07-I-03	T303046-21	03/17/2003
07-30-S	T303046-25	03/182003
07-31-F	T303046-26	03/182003

Sample	Lab Sample Number	Date Sampled
07-36-F	T303046-27	03/182003
07-36-S	T303046-28	03/182003
07-37-F	T303046-29	03/182003
07-38-F	T303046-30	03/182003
07-38-S	T303046-31	03/182003
07-40-F	T303046-32	03/182003
07-42-S (Field Duplicate of 07-30-S)	T303046-33	03/182003
07-JA-1	T303046-34	03/182003
07-JA-2	T303046-35	03/182003
Field Blanks		
07-43-F	T303046-19	03/17/2003
07-44-S	T303046-22	03/17/2003
Equipment Blank		
07-44-F	T303046-09	03/17/2003
Bottle Blanks		
07-43-S	T303046-16	03/17/2003
PE Sample		
07-20-F	T303046-23	03/17/2003
PE Sample Blank		
07-20-S	T303046-24	03/17/2003
Trip Blank		
Trip Blank	T303046-36	03/182003
Laboratory Refrigerator Blank		
Laboratory Refrigerator Blank	T303046-37	03/182003

ATTACHMENT A
DATA VALIDATION QUALIFIER DEFINITIONS AND INTERPRETATION KEY
Assigned by the URS Data Review Team

DATA QUALIFIER DEFINITIONS

U The analyte was analyzed for, but was not detected above the reported sample quantitation limit.

J The analyte was positively identified; the associated numerical value is the approximate concentration of the analyte in the sample.

N The analysis indicates the presence of an analyte for which there is presumptive evidence to make a "tentative identification."

NJ The analysis indicates the presence of an analyte that has been "tentatively identified" and the associated numerical value represents its approximate concentration.

UJ The analyte was not detected above the reported sample quantitation limit. However, the reported quantitation limit is approximate and may or may not represent the actual limit of quantitation necessary to accurately and precisely measure the analyte in the sample.

R The sample results are rejected due to serious deficiencies in the ability to analyze the sample and meet quality control criteria. The presence or absence of the analyte cannot be verified.

DATA QUALIFIER REASON CODE DEFINITIONS

a Analytical sequence deficiency or omission.
b Gross compound breakdown (4,4'-DDT/Endrin).
c Calibration failure; poor or unstable response.
d Laboratory duplicate imprecision.
e Laboratory duplicate control sample imprecision.
f Field duplicate imprecision.
g Poor chromatography.
h Holding time violation.
i Internal standard failure.
j Poor mass spectrographic performance.
k Serial dilution imprecision.
l Laboratory control sample recovery failure.
m Matrix spike/matrix spike duplicate recovery failure.
n Interference check sample recovery failure.
o Calibration blank contamination (metals/inorganics only).
p Preparation blank contamination (metals/inorganics only).
q Quantitation outside of linear range.
r Linearity failure in initial calibration.
s Surrogate spike recovery failure (GC organics and GC/MS organics only).
t Instrument tuning failure.
u No confirmation column present (GC Organics only).
v Value is estimated below the MDA (Rads only).
w Retention time (RT) outside of RT window.
x Field or equipment blank contamination.
y Trip blank contamination.
z Method blank contamination.
D Value exceeds quantitation limit.
Q Dissolved concentration significantly exceeded the total concentration.

RUN 8

DATE: May 20, 2003 **SITE:** Caltrans: Lake Tahoe Pilot Project

SUBJECT: **Caltrans: Lake Tahoe Pilot Project – Run 8**
ToxScan Report Nos.: T-303046 and T-303052

A limited data review (including electronic validation by Caltrans Laboratory EDD Processing Tool) was performed by the Sacramento Project Chemistry Group on ToxScan Report Nos.: T-303046 and T-303052 in support of the Caltrans: Lake Tahoe Pilot Project. The report contains analytical data for 37 aqueous samples (including three field duplicate pairs, one performance evaluation sample, two field blanks, one bottle blank, one equipment blank, and one performance evaluation blank). Sample IDs are listed in Table 1. Samples **08-35-F/08-41-F**, **08-PCA/08-42-S**, and **08-I-01/08-41-S** represent field duplicate pairs. The samples were collected between March 16 and 20, 2003 and submitted to ToxScan, Inc. in Watsonville, California for analysis of Nitrate (EPA Method 300.0), Nitrite (EPA Method 300.0), Oil and Grease (EPA Method 1664), Total Alkalinity (EPA Method 310.1), Total and Dissolved Aluminum (EPA Method 200.8), Acid Soluble Aluminum (EPA Method 440/5-86-008), Total Ammonia (SM-4500), Total and Dissolved Iron (EPA Method 200.7), Total and Dissolved Ortho-Phosphate (EPA Method 365.2), Total and Dissolved Kjeldahl Nitrogen (EPA Method 351.3), Total Organic Carbon (EPA Method 415.1), Total and Dissolved Phosphorous (EPA Method 365.2), Total Dissolved Solids (TDS; EPA Method 160.1), and Total Suspended Solids (TSS; EPA Method 160.2).

The data were reviewed in accordance with analytical methods outlined in EPA SW-846 and Analysis of Water and Wastewater. The following presents an overview of the limited data validation. The areas reviewed are listed below. A check mark (3) indicates an area of review in which all data were acceptable without qualification; a crossed circle (⊗) signifies areas where issues raised during validation impacted data quality and/or usability.

- ✓ Data Completeness
- ✓ Holding Times
- ⊗ Blanks
- ✓ Laboratory Control Samples
- ✓ Matrix Spike/Matrix Spike Duplicates
- ✓ Laboratory Duplicates
- ✓ Field Duplicates
- ⊗ Total/Dissolved Comparison
- ✓ Performance Evaluation Sample
- ✓ Analyte Quantification

Data Completeness

The sample analyses were performed as requested on the chain-of-custody records with the exceptions summarized in the following table.

Analyte	Analysis Requested	Analysis Performed
Total Kjeldahl Nitrogen	EPA Method 351.3	EPA Method 351.1
Dissolved Kjeldahl Nitrogen	EPA Method 351.3	EPA Method 351.1

Holding Time and Preservation

The samples were analyzed within the holding times specified in the Caltrans: Guidance Manual: Storm Water Monitoring Protocols.

Blanks

The blanks with target analyte contamination are listed in the following table.

Blank	Contaminant	Concentration
08-43-F (Field Blank)	Total Dissolved Solids	2.0 mg/L
08-44-S (Field Blank)	Total Dissolved Solids	8.0 mg/L
	Total Suspended Solids	2.0 mg/L
08-44-F (Equipment Blank)	Total Dissolved Solids	6.0 mg/L
	Dissolved Aluminum	38 µg/L
08-43-S (Trip Blank)	Total Dissolved Solids	8.0 mg/L
Laboratory Refrigerator Blank	Total Organic Carbon	15 mg/L

A sample result was qualified as anomalous (U) if instrument concentration of the sample was within five-times the instrument concentration of an associated blank. The qualified data are summarized in the following table. Although Total Organic Carbon was reported in the refrigerator blank, all other blanks were free of Total Organic Carbon. In addition, the performance evaluation sample, which was submitted with the project samples, was not impacted by the contamination. Consequently, the project sample data were not qualified based on the refrigerator blank contamination.

Analyte	Qualifier	Samples Qualified	Concentration
Dissolved Aluminum	U	**08-33-F** **08-41-S** **08-PA**	26 µg/L 34 µg/L 25 µg/L
Total Dissolved Solids	U	**None**	NA
Total Suspended Solids	U	**08-CFS** **08-PA**	6.0 mg/L 2.0 mg/L
Total Organic Carbon	U	**None**	NA

Laboratory Control Samples

The LCS recoveries for all analytes were within acceptance limits.

Matrix Spike and Matrix Spike Duplicate

The following table lists the project samples utilized for the Matrix Spike/Matrix Spike Duplicate analyses. The recoveries and relative percent differences were within the acceptance criteria.

Analyte	Project Sample(s) Utilized
Acid Soluble, Dissolved, and Total Aluminum, Dissolved and Total Iron, Dissolved and Total Kjeldahl Nitrogen, Total Organic Carbon, Nitrate, Nitrite, Dissolved and Total Ortho-Phosphate, and Dissolved and Total Phosphorus	**08-32-F, 08-PA, and 08-36-S**

Laboratory Duplicates

The following table lists the project samples utilized for the Laboratory Duplicate analyses.

Analyte	Project Sample(s) Utilized
Total Alkalinity, Acid Soluble, Dissolved, and Total Aluminum, Dissolved and Total Iron, Dissolved and Total Kjeldahl Nitrogen, Oil and Grease, Total Organic Carbon, Nitrate, Nitrite, Dissolved and Total Ortho-Phosphate, and Dissolved and Total Phosphorus	**08-32-F, 08-PA, and 08-36-S**
Total Dissolved Solids and Total Suspended Solids	**08-PA and 08-CPFS**

The relative percent differences for all analytes were within the acceptance criteria.

Field Duplicates

The field duplicate pairs, **08-35-F/08-41-F**, **08-PCA/08-42-S**, and **08-I-01/08-41-S,** demonstrated acceptable field and laboratory precision for all analytes.

Total/Dissolved Comparison

For all samples, a comparison of the total and dissolved data demonstrated acceptable results for all analytes except those listed in the following table.

Sample	Analyte	Total Result	Dissolved Result	Qualifier
08-36-F	Aluminum	130 µg/L	250 µg/L	**J[1]**
08-37-F	Phosphorus	0.043 mg/L	0.063 mg/L	**J[2]**
08-38-F	Kjeldahl Nitrogen	0.15 mg/L	0.28 mg/L	**J[2]**
08-40-F	Kjeldahl Nitrogen	<0.10 mg/L	0.27 mg/L	**J[2]**
08-CFS	Kjeldahl Nitrogen	0.22 mg/L	0.34 mg/L	**J[2]**
08-CPFS	Kjeldahl Nitrogen	0.19 mg/L	0.41 mg/L	**R[3]**

Notes:
1. The dissolved concentration exceeded the acid soluble aluminum concentration by more than the reporting limit or 10%. The data were estimated (J).
2. The dissolved concentration exceeded the total concentration by more than the reporting limit or 10%. The data were estimated (J).
3. The dissolved concentration exceeded the total concentration by more than 2-times the reporting limit or 20%. The data were rejected.

Performance Evaluation Sample

Samples **07-20-F** and **07-20-S** were submitted to the laboratory as a double blind performance evaluation sample and an associated reference blank. The results for all certified analytes are summarized below.

Sample 07-20-F				
Analyte	**Certified Value**	**Laboratory Result**	**Acceptance Criteria**	**Pass/Fail**
Total Organic Carbon	20.0 mg/L	19 mg/L	17.3 – 22.8 mg/L	Pass
Dissolved Kjeldahl Nitrogen	0.50 mg/L	0.42 mg/L	0.385 – 0.620 mg/L	Pass
Total Kjeldahl Nitrogen	0.50 mg/L	0.49 mg/L	0.385 – 0.620 mg/L	Pass

Sample 07-20-F				
Analyte	**Certified Value**	**Laboratory Result**	**Acceptance Criteria**	**Pass/Fail**
Dissolved Phosphorous	0.10 mg/L	0.1 mg/L	0.0831 – 0.117 mg/L	Pass
Total Phosphorous	0.10 mg/L	0.1 mg/L	0.0831 – 0.117 mg/L	Pass
Dissolved Iron	0.500 mg/L	0.440 µg/L	0.437 – 0.565 mg/L	Pass
Total Iron	0.500 mg/L	0.450 mg/L	0.437 – 0.565 mg/L	Pass
Sample 07-20-S				
Analyte	**Certified Value**	**Laboratory Result**	**Acceptance Criteria**	**Pass/Fail**
Total Organic Carbon	--	ND	--	--
Dissolved Kjeldahl Nitrogen	--	ND	--	--
Total Kjeldahl Nitrogen	--	ND	--	--
Dissolved Phosphorous	--	ND	--	--
Total Phosphorous	--	ND	--	--
Dissolved Iron	--	ND	--	--
Total Iron	--	ND	--	--

Acceptable results were obtained for all seven certified analytes.

Analyte Quantification

The project-specific reporting limits were met for all analytes.

Table 1. Lake Tahoe Pilot Project Samples

Sample	Lab Sample Number	Date Sampled
Project Samples		
08-001	T303046-01	03/16/2003
08-JA-1	T303052-01	03/17/2003
08-JA-2	T303052-02	03/17/2003
08-I-01	T303052-03	03/18/2003
08-I-03	T303052-04	03/19/2003
08-33-S	T303052-05	03/19/2003
08-35-S	T303052-06	03/18/2003
08-41-S (Field Duplicate of 08-I-01)	T303052-07	03/18/2003
08-41-F (Field Duplicate of 08-35-F)	T303052-09	03/19/2003
08-34-F	T303052-10	03/19/2003
08-32-F	T303052-11	03/19/2003
08-35-F	T303052-12	03/19/2003
08-34-S	T303052-13	03/19/2003
08-33-F	T303052-14	03/19/2003
08-PFF	T303052-18	03/19/2003
08-PCA	T303052-19	03/19/2003
08-PA	T303052-20	03/19/2003
08-42-S (Field Duplicate of 08-PCA)	T303052-21	03/19/2003
08-30-S	T303052-22	03/20/2003
08-31-F	T303052-23	03/20/2003
08-36-F	T303052-24	03/20/2003
08-36-S	T303052-25	03/20/2003
08-37-F	T303052-26	03/20/2003
08-38-F	T303052-27	03/20/2003
08-38-S	T303052-28	03/20/2003
08-40-F	T303052-29	03/20/2003
08-CCA	T303052-30	03/19/2003
08-CFS	T303052-31	03/19/2003
08-CPFS	T303052-32	03/19/2003
Field Blanks		
08-43-F	T303052-15	03/17/2003
08-44-S	T303052-16	03/17/2003
Equipment Blank		
08-44-F	T303052-17	03/17/2003
Bottle Blank		
08-43-S	T303052-08	03/17/2003

Sample	Lab Sample Number	Date Sampled
PE Sample		
07-20-F	T303046-23	03/17/2003
PE Sample Blank		
07-20-S	T303046-24	03/17/2003
Trip Blank		
Trip Blank	T303046-36	03/182003
Laboratory Refrigerator Blank		
Laboratory Refrigerator Blank	T303046-37	03/182003

RUN 9

DATE: June 26, 2003 **SITE:** Caltrans: Lake Tahoe Pilot Project

SUBJECT: **Caltrans: Lake Tahoe Pilot Project – Run 9**
ToxScan Report No.: T-305008

A limited data review (including electronic validation by Caltrans Laboratory EDD Processing Tool) was performed by the Sacramento Project Chemistry Group on ToxScan Report No.: T-305008 in support of the Caltrans: Lake Tahoe Pilot Project. The report contains analytical data for 36 aqueous samples (including three field duplicate pairs, one performance evaluation sample, two field blanks, one bottle blank, one equipment blank, and one performance evaluation blank). Sample IDs are listed in Table 1. Samples **09-PFF/09-41-F**, **09-30-S/09-42-S**, and **09-I-01/09-41-S** represent field duplicate pairs. The samples were collected between May 6 and 8, 2003 and submitted to ToxScan, Inc. in Watsonville, California for analysis of Nitrate (EPA Method 300.0), Nitrite (EPA Method 300.0), Oil and Grease (EPA Method 1664), Total Alkalinity (EPA Method 310.1), Total and Dissolved Aluminum (EPA Method 200.8), Acid Soluble Aluminum (EPA Method 440/5-86-008), Total Ammonia (SM-4500), Total and Dissolved Iron (EPA Method 200.7), Total and Dissolved Ortho-Phosphate (EPA Method 365.2), Total and Dissolved Kjeldahl Nitrogen (EPA Method 351.3), Total Organic Carbon (EPA Method 415.1), Total and Dissolved Phosphorous (EPA Method 365.2), Total Dissolved Solids (TDS; EPA Method 160.1), and Total Suspended Solids (TSS; EPA Method 160.2).

The data were reviewed in accordance with analytical methods outlined in EPA SW-846 and Analysis of Water and Wastewater. The following presents an overview of the limited data validation. The areas reviewed are listed below. A check mark (3) indicates an area of review in which all data were acceptable without qualification; a crossed circle (⊗) signifies areas where issues raised during validation impacted data quality and/or usability.

- ✓ Data Completeness
- ⊗ Holding Times
- ⊗ Blanks
- ✓ Laboratory Control Samples
- ✓ Matrix Spike/Matrix Spike Duplicates
- ⊗ Laboratory Duplicates
- ⊗ Field Duplicates
- ⊗ Total/Dissolved Comparison
- ✓ Performance Evaluation Sample
- ✓ Analyte Quantification

Data Completeness
Sample **09-PA** (T-305008-16) was incorrectly identified as **09-32-F** (T-305008-15) on the Analysis Batch Quality Control Report for Batch TotO-P_050803b for Total Ortho Phosphorous. The sample number was corrected, dated, and initialed by the data reviewer.

The sample analyses were performed as requested on the chain-of-custody records with the exceptions summarized in the following table.

Analyte	Analysis Requested	Analysis Performed
Total Kjeldahl Nitrogen	EPA Method 351.3	EPA Method 351.1
Dissolved Kjeldahl Nitrogen	EPA Method 351.3	EPA Method 351.1

Holding Time and Preservation

The samples were analyzed within the holding times specified in the Caltrans: Guidance Manual: Storm Water Monitoring Protocols with the exception of the nitrate, nitrite, and total and dissolved ortho-phosphate analyses of samples **09-I-03**, **09-35-S**, **09-41-S**, **09-43-F**, **09-43-S**, and **09-44-S**. The nitrate/nitrite and total and dissolved ortho-phosphate data for these samples should be considered estimated (J). It should be noted that these samples were received with insufficient time to perform the analyses within holding times.

Blanks

The blanks with target analyte contamination are listed in the following table.

Blank	Contaminant	Concentration
09-43-F (Field Blank)	Total Alkalinity	29 mg/L
	Dissolved Kjeldahl Nitrogen	0.21 mg/L
	Total Ortho-Phosphate	0.031 mg/L
09-44-S (Field Blank)	Dissolved Kjeldahl Nitrogen	0.14 mg/L
08-44-F (Equipment Blank)	Total Alkalinity	1.0 mg/L
	Dissolved Kjeldahl Nitrogen	0.18 mg/L

A sample result was qualified as anomalous (U) if instrument concentration of the sample was within five-times the instrument concentration of an associated blank. The qualified data are summarized in the following table.

Analyte	Qualifier	Samples Qualified	Concentration
Total Alkalinity	U	**09-30-S**	39 mg/L
		09-31-F	45 mg/L
		09-32-F	45 mg/L
		09-33-F	47 mg/L
		09-33-S	36 mg/L
		09-34-S	20 mg/L
		09-35-F	43 mg/L
		09-35-S	27 mg/L
		09-36-F	49 mg/L
		09-36-S	38 mg/L
		09-37-F	97 mg/L
		09-38-F	69 mg/L
		09-38-S	38 mg/L
		09-40-F	52 mg/L
		09-41-F	20 mg/L
		09-41-S	37 mg/L
		09-42-S	37 mg/L
		09-CCA	20 mg/L
		09-CFS	21 mg/L
		09-CPFS	24 mg/L

Analyte	Qualifier	Samples Qualified	Concentration
		09-I-01	37 mg/L
Total Alkalinity (cont.)	U	**09-I-03**	37 mg/L
		09-PA	21 mg/L
		09-PCA	7.2 mg/L
		09-PFF	20 mg/L
Dissolved Kjeldahl Nitrogen	U	**09-30-S**	0.37 mg/L
		09-31-F	0.48 mg/L
		09-32-F	0.33 mg/L
		09-33-F	0.51 mg/L
		09-33-S	0.50 mg/L
		09-34-F	0.28 mg/L
		09-34-S	0.53 mg/L
		09-35-F	0.37 mg/L
		09-35-S	0.55 mg/L
		09-36-F	0.41 mg/L
		09-36-S	0.30 mg/L
		09-37-F	0.33 mg/L
		09-38-F	0.47 mg/L
		09-38-S	0.38 mg/L
		09-40-F	0.15 mg/L
		09-41-F	0.42 mg/L
		09-42-S	0.36 mg/L
		09-CCA	0.24 mg/L
		09-CFS	0.40 mg/L
		09-CPFS	0.38 mg/L
		09-I-01	0.47 mg/L
		09-I-03	0.64 mg/L
		09-PA	0.24 mg/L
		09-PCA	0.25 mg/L
		09-PFF	0.50 mg/L
Total Ortho-Phosphate	U	**09-31-F**	0.057 mg/L
		09-32-F	0.067 mg/L
		09-33-F	0.092 mg/L
		09-33-S	0.047 mg/L
		09-35-F	0.064 mg/L
		09-35-S	0.062 mg/L
		09-36-F	0.074 mg/L
		09-41-S	0.064 mg/L
		09-I-01	0.079 mg/L

Laboratory Control Samples

The LCS recoveries for all analytes were within acceptance limits.

Matrix Spike and Matrix Spike Duplicate

The following table lists the project samples utilized for the Matrix Spike/Matrix Spike Duplicate analyses. The recoveries and relative percent differences were within the acceptance criteria.

Analyte	Project Sample(s) Utilized
Acid Soluble, Dissolved, and Total Aluminum, Dissolved and Total Iron, Dissolved and Total Kjeldahl Nitrogen, Total Organic Carbon, Nitrate, Nitrite, Dissolved and Total Ortho-Phosphate, and Dissolved and Total Phosphorus	**09-32-F**, **09-PA**, and **09-36-S**

Laboratory Duplicates

The following table lists the project samples utilized for the Laboratory Duplicate analyses.

Analyte	Project Sample(s) Utilized
Total Alkalinity, Acid Soluble, Dissolved, and Total Aluminum, Dissolved and Total Iron, Dissolved and Total Kjeldahl Nitrogen, Oil and Grease, Total Organic Carbon, Nitrate, Nitrite, Dissolved and Total Ortho-Phosphate, and Dissolved and Total Phosphorus	**09-32-F**, **09-PA**, and **09-36-S**
Total Dissolved Solids and Total Suspended Solids	**09-32-F** and **09-I-03**

The relative percent differences were within the QAPP-specified acceptance criteria except for those listed in the following table. The relative percent differences were within the QAPP-specified acceptance criteria except for the analytes listed in the following table.

Analyte	Duplicate Sample	RPD	Qualifier	Samples Qualified
Dissolved Kjeldahl Nitrogen	**09-36-S**	26%	**J**[1]	**09-36-S, 09-37-F, 09-38-F, 09-38-S, 09-40-F, 09-42-S, 09-CCA, 09-CFS, 09-CPSF, 09-I-03**
Total Kjeldahl Nitrogen	**09-32-F**	24%	**J**[1]	**09-32-F, 09-33-F, 09-33-S, 09-34-F, 09-34-S, 09-35-F, 09-35-S, 09-41-F, 09-41-S, 09-I-01, 09-PCA, 09-PFF**
Total Kjeldahl Nitrogen	**09-PA**	23%	**J**[1]	**09-30-S, 09-31-F, 09-36-S, 09-PA**
Note: 1. The primary and duplicate results differ by more than 20%, therefore, the data were considered estimated (J).				

Field Duplicates

The field duplicate pairs, **09-PFF/09-41-F**, **09-30-S/09-42-S**, and **09-I-01/09-41-S**, demonstrated acceptable field and laboratory precision for all analytes except those listed below.

09-PFF/09-41-F			
Analyte	**Primary Sample Result**	**Field Duplicate Result**	**Qualifier**
Dissolved Iron	120 µg/L	ND (25 µg/L)	**J**[1]
09-30-S/09-42-S			
Analyte	**Primary Sample Result**	**Field Duplicate Result**	**Qualifier**
Total Phosphorous	0.12 mg/L	ND (0.03 mg/L)	**J**[1]
09-I-01/09-41-S			
Analyte	**Primary Sample Result**	**Field Duplicate Result**	**Qualifier**
Dissolved Kjeldahl Nitrogen	0.47 mg/L	1.3 mg/L	**J**[1]
Note: 1. The primary and duplicate results differ by more than 50%, therefore, the data were considered estimated (J).			

Total/Dissolved Comparison

For all samples, a comparison of the total and dissolved data demonstrated acceptable results for all analytes except those listed in the following table.

Sample	Analyte	Total Result	Dissolved Result	Qualifier
09-PFF	Iron	ND (25µg/L)	120 µg/L	**R**[1]
	Kjeldahl Nitrogen	0.23 mg/L	0.50 mg/L	**J**[2]
09-CPFS	Kjeldahl Nitrogen	0.23 mg/L	0.38 mg/L	**J**[2]
09-CCA	Kjeldahl Nitrogen	0.12 mg/L	0.24 mg/L	**J**[2]
09-CFS	Kjeldahl Nitrogen	0.26 mg/L	0.40 mg/L	**J**[2]
09-34-S	Kjeldahl Nitrogen	0.33 mg/L	0.53 mg/L	**J**[2]
09-38-F	Kjeldahl Nitrogen	0.28 mg/L	0.47 mg/L	**J**[2]
09-41-S	Kjeldahl Nitrogen	0.70 mg/L	1.3 mg/L	**R**[1]
09-41-F	Kjeldahl Nitrogen	0.25 mg/L	0.42 mg/L	**J**[2]

Notes:

1. The dissolved concentration exceeded the total concentration by more than 2-times the reporting limit or 20%. The data were rejected.
2. The dissolved concentration exceeded the total concentration by more than the reporting limit or 10%. The data were estimated (J).

Performance Evaluation Sample

Samples **09-45-F** and **09-45-S** were submitted to the laboratory as a double blind performance evaluation sample and an associated reference blank. The results for all certified analytes are summarized below. Acceptable results were obtained for all seven certified analytes.

Sample 09-45-F				
Analyte	**Certified Value**	**Laboratory Result**	**Acceptance Criteria**	**Pass/Fail**
Total Organic Carbon	20.0 mg/L	19 mg/L	17.3 – 22.8 mg/L	Pass
Dissolved Kjeldahl Nitrogen	0.50 mg/L	0.55 mg/L	0.385 – 0.620 mg/L	Pass
Total Kjeldahl Nitrogen	0.50 mg/L	0.55 mg/L	0.385 – 0.620 mg/L	Pass
Dissolved Phosphorous	0.10 mg/L	0.11 mg/L	0.0831 – 0.117 mg/L	Pass
Total Phosphorous	0.10 mg/L	0.10 mg/L	0.0831 – 0.117 mg/L	Pass
Dissolved Iron	0.500 mg/L	0.460 µg/L	0.437 – 0.565 mg/L	Pass
Total Iron	0.500 mg/L	0.470 mg/L	0.437 – 0.565 mg/L	Pass
Sample 09-45-S				
Analyte	**Certified Value**	**Laboratory Result**	**Acceptance Criteria**	**Pass/Fail**
Total Organic Carbon	--	ND	--	--
Dissolved Kjeldahl Nitrogen	--	ND	--	--
Total Kjeldahl Nitrogen	--	ND	--	--
Dissolved Phosphorous	--	ND	--	--
Total Phosphorous	--	ND	--	--
Dissolved Iron	--	ND	--	--
Total Iron	--	ND	--	--

Analyte Quantification

The project-specific reporting limits were met for all analytes.

Table 1. Lake Tahoe Pilot Project Samples

Sample	Lab Sample Number	Date Sampled
Project Samples		
09-33-F	T-305008-01	05/07/2003
09-33-S	T-305008-02	05/07/2003
09-I-01	T-305008-03	05/06/2003
09-41-S (Field Duplicate of 09-I-01)	T-305008-06	05/06/2003
09-35-S	T-305008-07	05/06/2003
09-34-S	T-305008-09	05/07/2003
09-34-F	T-305008-10	05/07/2003
09-35-F	T-305008-11	05/07/2003
09-41-F (Field Duplicate of 09-PFF)	T-305008-12	05/07/2003
09-PFF	T-305008-13	05/07/2003
09-PCA	T-305008-14	05/07/2003
09-32-F	T-305008-15	05/07/2003
09-PA	T-305008-16	05/07/2003
09-30-S	T-305008-17	05/08/2003
09-31-F	T-305008-18	05/08/2003
09-36-F	T-305008-19	05/08/2003
09-36-S	T-305008-20	05/08/2003
09-37-F	T-305008-21	05/08/2003
09-38-F	T-305008-22	05/08/2003
09-38-S	T-305008-23	05/08/2003
09-40-F	T-305008-24	05/08/2003
09-42-S (Field Duplicate of 09-30-S)	T-305008-25	05/08/2003
09-CCA	T-305008-29	05/08/2003
09-CFS	T-305008-30	05/08/2003
09-CPFS	T-305008-31	05/08/2003
09-I-03	T-305008-32	05/07/2003
09-JA-01	T-305008-33	05/06/2003
09-JA-2	T-305008-34	05/06/2003
Field Blanks		
09-43-F	T-305008-04	05/06/2003
09-44-S	T-305008-05	05/06/2003
Field Blank	T-305008-35	05/06/2003
Equipment Blank		
09-44-F	T-305008-26	05/07/2003
Bottle Blank		
09-43-S	T-305008-08	05/06/2003
PE Sample		
09-45-F	T-305008-27	05/07/2003
PE Sample Blank		
09-45-S	T-305008-28	05/07/2003
Trip Blank		
Trip Blank	T-205008-36	05/06/2003

Run 10

DATE: June 30, 2003 **SITE:** Caltrans: Lake Tahoe Pilot Project

SUBJECT: **Caltrans: Lake Tahoe Pilot Project – Run 10**
ToxScan Report No.: T-305011

A limited data review (including electronic validation by Caltrans Laboratory EDD Processing Tool) was performed by the Sacramento Project Chemistry Group on ToxScan Report No.: T-305011 in support of the Caltrans: Lake Tahoe Pilot Project. The report contains analytical data for 35 aqueous samples (including three field duplicate pairs, one performance evaluation sample, two field blanks, one bottle blank, one equipment blank, and one performance evaluation blank). Sample IDs are listed in Table 1. Samples **10-PA/10-41-F**, **10-38-S/10-42-S**, and **10-I-01/10-41-S** represent field duplicate pairs. The samples were collected between May 8 and 10, 2003 and submitted to ToxScan, Inc. in Watsonville, California for analysis of Nitrate (EPA Method 300.0), Nitrite (EPA Method 300.0), Oil and Grease (EPA Method 1664), Total Alkalinity (EPA Method 310.1), Total and Dissolved Aluminum (EPA Method 200.8), Acid Soluble Aluminum (EPA Method 440/5-86-008), Total Ammonia (SM-4500), Total and Dissolved Iron (EPA Method 200.7), Total and Dissolved Ortho-Phosphate (EPA Method 365.2), Total and Dissolved Kjeldahl Nitrogen (EPA Method 351.3), Total Organic Carbon (EPA Method 415.1), Total and Dissolved Phosphorous (EPA Method 365.2), Total Dissolved Solids (TDS; EPA Method 160.1), and Total Suspended Solids (TSS; EPA Method 160.2).

The data were reviewed in accordance with analytical methods outlined in EPA SW-846 and Analysis of Water and Wastewater. The following presents an overview of the limited data validation. The areas reviewed are listed below. A check mark (3) indicates an area of review in which all data were acceptable without qualification; a crossed circle (⊗) signifies areas where issues raised during validation impacted data quality and/or usability.

- ✓ Data Completeness
- ⊗ Holding Times
- ⊗ Blanks
- ✓ Laboratory Control Samples
- ✓ Matrix Spike/Matrix Spike Duplicates
- ✓ Laboratory Duplicates
- ✓ Field Duplicates
- ⊗ Total/Dissolved Comparison
- ✓ Performance Evaluation Sample
- ✓ Analyte Quantification

Data Completeness
The sample analyses were performed as requested on the chain-of-custody records with the exceptions summarized in the following table.

Analyte	Analysis Requested	Analysis Performed
Total Kjeldahl Nitrogen	EPA Method 351.3	EPA Method 351.1
Dissolved Kjeldahl Nitrogen	EPA Method 351.3	EPA Method 351.1

Holding Time and Preservation

The samples were analyzed within the holding times specified in the Caltrans: Guidance Manual: Storm Water Monitoring Protocols with the exception of the nitrate, nitrite, total and dissolved ortho-phosphate, and oil and grease analyses listed below. The data for these analyses in the samples should be considered estimated (J). It should be noted that these samples were received with insufficient time to perform the nitrate/nitrite analyses within holding times.

Analyte	Samples
Nitrate	**10-32-F, 10-33-F, 10-33-S, 10-34-F, 10-34-S, 10-35-F, 10-35-S, 10-41-F, 10-41-S, 10-CCA, 10-CFS, 10-CPFS, 10-I-01, 10-I-03, 10-PA, 10-PCA, and 10-PFF**
Nitrite	**10-32-F, 10-33-F, 10-33-S, 10-34-F, 10-34-S, 10-35-F, 10-35-S, 10-41-F, 10-41-S, 10-CCA, 10-CFS, 10-CPFS, 10-I-01, 10-I-03, 10-PA, 10-PCA, and 10-PFF**
Total ortho-Phosphate	**10-32-F, 10-33-F, 10-33-S, 10-34-F, 10-34-S, 10-35-F, 10-35-S, 10-41-F, 10-41-S, 10-CCA, 10-CFS, 10-CPFS, 10-I-01, 10-I-03, 10-PA, 10-PCA, and 10-PFF**
Dissolved ortho-Phosphate	**10-32-F, 10-33-F, 10-33-S, 10-34-F, 10-34-S, 10-35-F, 10-35-S, 10-41-F, 10-41-S, 10-CCA, 10-CFS, 10-CPFS, 10-I-01, 10-I-03, 10-PA, 10-PCA, and 10-PFF**
Oil and Grease	**10-41-F, 10-41-S, 10-CCA, 10-CFS, 10-CPFS, 10-I-01, 10-I-03, 10-PA, 10-PCA, and 10-PFF**

Blanks

The blanks with target analyte contamination are listed in the following table. The total aluminum result reported for field blank, **10-44-S**, was not confirmed when reanalyzed by EPA 200.7. Since the balance of the samples were not reanalyzed, the data were qualified based on the original result.

Blank	Contaminant	Concentration
10-43-F (Field Blank)	Total Kjeldahl Nitrogen	0.12 mg/l
	Dissolved Kjeldahl Nitrogen	0.15 mg/l
	Ammonia Nitrogen	0.12 mg/l
10-44-S (Field Blank)	Aluminum	93 µg/L
	Total Kjeldahl Nitrogen	0.13 mg/l
	Dissolved Kjeldahl Nitrogen	0.23 mg/l
10-44-F (Equipment Blank)	Total Kjeldahl Nitrogen	0.16 mg/l
	Dissolved Kjeldahl Nitrogen	0.22 mg/l
10-43-S (Bottle Blank)	Total Kjeldahl Nitrogen	0.18 mg/l
	Dissolved Kjeldahl Nitrogen	0.11 mg/l
Laboratory Method Blank	Total Kjeldahl Nitrogen	0.106 mg/l

A sample result was qualified as anomalous (U) if instrument concentration of the sample was within five-times the instrument concentration of an associated blank. The qualified data are summarized in the following table.

Analyte	Qualifier	Samples Qualified	Concentration
Aluminum	U	**10-30-S**	56 µg/L
		10-31-F	97 µg/L
		10-32-F	110 µg/L
		10-33-F	120 µg/L
		10-33-S	290 µg/L
		10-35-S	390 µg/L
		10-36-F	92 µg/L
		10-36-S	140 µg/L
		10-37-F	190 µg/L
		10-38-F	41 µg/L
		10-38-S	80 µg/L
		10-41-F	140 µg/L
		10-41-S	390 µg/L
		10-42-S	70 µg/L
		10-CFS	160 µg/L
		10-I-01	320 µg/L
		10-I-03	320 µg/L
		10-PA	140 µg/L
		10-PCA	43 µg/L
Total Kjeldahl Nitrogen	U	**10-30-S**	0.22 mg/L
		10-31-F	0.21 mg/L
		10-32-F	0.22 mg/L
		10-33-F	0.21 mg/L
		10-33-S	0.23 mg/L
		10-34-F	0.17 mg/L
		10-34-S	0.17 mg/L
		10-35-F	0.20 mg/L
		10-35-S	0.22 mg/L
		10-36-F	0.22 mg/L
		10-36-S	0.23 mg/L
		10-37-F	0.17 mg/L
		10-38-F	0.26 mg/L
		10-38-S	0.24 mg/L
		10-40-F	0.16 mg/L
		10-41-F	0.24 mg/L
		10-41-S	0.26 mg/L
		10-42-S	0.19 mg/L
		10-CCA	0.15 mg/L
		10-CFS	0.19 mg/L
		10-CPFS	0.16 mg/L
		10-I-01	0.25 mg/L
		10-I-03	0.26 mg/L
		10-PA	0.20 mg/L
		10-PCA	0.14 mg/L
		10-PFF	0.21 mg/L
Dissolved Kjeldahl Nitrogen	U	**10-30-S**	0.30 mg/L
		10-31-F	0.17 mg/L
		10-32-F	0.27 mg/L
		10-33-F	0.15 mg/L
		10-33-S	0.24 mg/L
		10-34-F	0.22 mg/L
		10-34-S	0.28 mg/L
		10-35-F	0.24 mg/L
		10-35-S	0.25 mg/L
		10-36-F	0.27 mg/L
		10-36-S	0.22 mg/L
		10-37-F	0.19 mg/L
		10-38-F	0.24 mg/L
Dissolved Kjeldahl Nitrogen	U	**10-38-S**	0.21 mg/L

Analyte	Qualifier	Samples Qualified	Concentration
(cont.)		**10-40-F**	0.15 mg/L
		10-41-F	0.23 mg/L
		10-41-S	0.19 mg/L
		10-42-S	0.31 mg/L
		10-CCA	0.22 mg/L
		10-CFS	0.19 mg/L
		10-CPFS	0.23 mg/L
		10-I-01	0.32 mg/L
		10-I-03	0.32 mg/L
		10-PA	0.27 mg/L
		10-PCA	0.14 mg/L
		10-PFF	0.26 mg/L

Laboratory Control Samples

The LCS recoveries for all analytes were within acceptance limits.

Matrix Spike and Matrix Spike Duplicate

The following table lists the project samples utilized for the Matrix Spike/Matrix Spike Duplicate analyses. The recoveries and relative percent differences were within the acceptance criteria.

Analyte	Project Sample(s) Utilized
Acid Soluble, Dissolved, and Total Aluminum, Dissolved and Total Iron, Dissolved and Total Kjeldahl Nitrogen, Total Organic Carbon, and Dissolved and Total Phosphorus	**10-32-F, 10-36-S,** and **10-PA**
Nitrate, Nitrite, and Dissolved and Total Ortho-Phosphate	**09-36-S, 10-32-F, 10-36-S,** and **10-PA**

The relative percent differences were within the QAPP-specified acceptance criteria.

Laboratory Duplicates

The following table lists the project samples utilized for the Laboratory Duplicate analyses.

Analyte	Project Sample(s) Utilized
Acid Soluble, Dissolved, and Total Aluminum, Dissolved and Total Iron, Dissolved and Total Kjeldahl Nitrogen, Total Organic Carbon, and Dissolved and Total Phosphorus	**10-32-F, 10-36-S,** and **10-PA**
Nitrate, Nitrite, and Dissolved and Total Ortho-Phosphate	**09-36-S, 10-32-F, 10-36-S,** and **10-PA**
Total Dissolved Solids and Total Suspended Solids	**10-36-S** and **10-PA**

Field Duplicates

The field duplicate pairs, **10-PA/10-41-F**, **10-38-S/10-42-S**, and **10-I-01/10-41-S**, demonstrated acceptable field and laboratory precision for all analytes except those listed below.

10-I-01/10-41-S			
Analyte	**Primary Sample Result**	**Field Duplicate Result**	**Qualifier**
Dissolved Kjeldahl Nitrogen	0.32 mg/L	0.19 mg/L	**J**[1]
Note: 1. The primary and duplicate results differ by more than 50%, therefore, the data were considered estimated (J).			

Total/Dissolved Comparison

For all samples, a comparison of the total and dissolved data demonstrated acceptable results for all analytes except those listed in the following table.

Sample	Analyte	Total Result	Dissolved Result	Qualifier
10-34-S	Kjeldahl Nitrogen	0.17 mg/L	0.28 mg/L	**J[1]**
10-42-S	Kjeldahl Nitrogen	0.19 mg/L	0.31 mg/L	**J[1]**

Notes:
1. The dissolved concentration exceeded the total concentration by more than the reporting limit or 10%. The data were estimated (J).

Performance Evaluation Sample

Samples **09-45-F** and **09-45-S** were submitted to the laboratory as a double blind performance evaluation sample and an associated reference blank. The results for all certified analytes are summarized below.

Sample 09-45-F				
Analyte	**Certified Value**	**Laboratory Result**	**Acceptance Criteria**	**Pass/Fail**
Total Organic Carbon	20.0 mg/L	19 mg/L	17.3 – 22.8 mg/L	Pass
Dissolved Kjeldahl Nitrogen	0.50 mg/L	0.55 mg/L	0.385 – 0.620 mg/L	Pass
Total Kjeldahl Nitrogen	0.50 mg/L	0.55 mg/L	0.385 – 0.620 mg/L	Pass
Dissolved Phosphorous	0.10 mg/L	0.11 mg/L	0.0831 – 0.117 mg/L	Pass
Total Phosphorous	0.10 mg/L	0.10 mg/L	0.0831 – 0.117 mg/L	Pass
Dissolved Iron	0.500 mg/L	0.460 µg/L	0.437 – 0.565 mg/L	Pass
Total Iron	0.500 mg/L	0.470 mg/L	0.437 – 0.565 mg/L	Pass
Sample 09-45-S				
Analyte	**Certified Value**	**Laboratory Result**	**Acceptance Criteria**	**Pass/Fail**
Total Organic Carbon	--	ND	--	--
Dissolved Kjeldahl Nitrogen	--	ND	--	--
Total Kjeldahl Nitrogen	--	ND	--	--
Dissolved Phosphorous	--	ND	--	--
Total Phosphorous	--	ND	--	--
Dissolved Iron	--	ND	--	--
Total Iron	--	ND	--	--

Acceptable results were obtained for all seven certified analytes.

Analyte Quantification

The project-specific reporting limits were met for all analytes.

Table 1. Lake Tahoe Pilot Project Samples

Sample	Lab Sample Number	Date Sampled
Project Samples		
10-JA-1	T-305011-05	05/07/2003
10-JA-2	T-305011-06	05/07/2003
10-I-01	T-305011-28	05/08/2003
10-I-03	T-305011-29	05/08/2003
10-33-S	T-305011-11	05/09/2003
10-35-S	T-305011-15	05/08/2003
10-41-S (Field Duplicate of 10-I-01)	T-305011-23	05/08/2003
10-41-F (Field Duplicate of 10-PA)	T-305011-22	05/08/2003
10-34-F	T-305011-12	05/09/2003
10-32-F	T-305011-09	05/09/2003
10-35-F	T-305011-14	05/09/2003
10-34-S	T-305011-13	05/09/2003
10-33-F	T-305011-10	05/09/2003
10-PFF	T-305011-32	05/08/2003
10-PCA	T-305011-31	05/08/2003
10-PA	T-305011-30	05/08/2003
10-42-S (Field Duplicate of 10-38-S)	T-305011-24	05/10/2003
10-30-S	T-305011-07	05/10/2003
10-31-F	T-305011-08	05/10/2003
10-36-F	T-305011-16	05/10/2003
10-36-S	T-305011-17	05/10/2003
10-37-F	T-305011-18	05/10/2003
10-38-F	T-305011-19	05/10/2003
10-38-S	T-305011-20	05/10/2003
10-40-F	T-305011-21	05/10/2003
10-CCA	T-305011-25	05/08/2003
10-CFS	T-305011-26	05/08/2003
10-CPFS	T-305011-27	05/08/2003
Field Blanks		
10-43-F	T-305011-01	05/08/2003
10-44-S	T-305011-04	05/08/2003
Equipment Blank		
10-44-F	T-305011-03	05/08/2003
Bottle Blank		
10-43-S	T-305011-02	05/08/2003
PE Sample		
09-45-F	T-305008-27	05/07/2003
PE Sample Blank		
09-45-S	T-305008-28	05/07/2003
Trip Blank		
Trip Blank	T-305008-36	05/06/2003

RUN 11

DATE: June 30, 2003 **SITE:** Caltrans: Lake Tahoe Pilot Project

SUBJECT: **Caltrans: Lake Tahoe Pilot Project – Run 11**
ToxScan Report No.: T-305028

A limited data review (including electronic validation by Caltrans Laboratory EDD Processing Tool) was performed by the Sacramento Project Chemistry Group on ToxScan Report No.: T-305028 in support of the Caltrans: Lake Tahoe Pilot Project. The report contains analytical data for 34 aqueous samples (including three field duplicate pairs, one performance evaluation sample, two field blanks, one bottle blank, one equipment blank, and one performance evaluation blank). Sample IDs are listed in Table 1. Samples **11-PFF/11-41-F**, **11-30-S/11-42-S**, and **11-I-01/11-41-S** represent field duplicate pairs. The samples were collected between May 20 and 22, 2003 and submitted to ToxScan, Inc. in Watsonville, California for analysis of Nitrate (EPA Method 300.0), Nitrite (EPA Method 300.0), Oil and Grease (EPA Method 1664), Total Alkalinity (EPA Method 310.1), Total and Dissolved Aluminum (EPA Method 200.8), Acid Soluble Aluminum (EPA Method 440/5-86-008), Total Ammonia (SM-4500), Total and Dissolved Iron (EPA Method 200.7), Total and Dissolved Ortho-Phosphate (EPA Method 365.2), Total and Dissolved Kjeldahl Nitrogen (EPA Method 351.3), Total Organic Carbon (EPA Method 415.1), Total and Dissolved Phosphorous (EPA Method 365.2), Total Dissolved Solids (TDS; EPA Method 160.1), and Total Suspended Solids (TSS; EPA Method 160.2).

The data were reviewed in accordance with analytical methods outlined in EPA SW-846 and Analysis of Water and Wastewater. The following presents an overview of the limited data validation. The areas reviewed are listed below. A check mark (3) indicates an area of review in which all data were acceptable without qualification; a crossed circle (⊗) signifies areas where issues raised during validation impacted data quality and/or usability.

- ✓ Data Completeness
- ⊗ Holding Times
- ⊗ Blanks
- ✓ Laboratory Control Samples
- ⊗ Matrix Spike/Matrix Spike Duplicates
- ⊗ Laboratory Duplicates
- ⊗ Field Duplicates
- ⊗ Total/Dissolved Comparison
- ✓ Analyte Quantification

Data Completeness
The sample analyses were performed as requested on the chain-of-custody records with the exceptions summarized in the following table.

Analyte	Analysis Requested	Analysis Performed
Total Kjeldahl Nitrogen	EPA Method 351.3	EPA Method 351.1
Dissolved Kjeldahl Nitrogen	EPA Method 351.3	EPA Method 351.1

Holding Time and Preservation

The samples were analyzed within the holding times specified in the Caltrans: Guidance Manual: Storm Water Monitoring Protocols with the exception of the nitrate, nitrite, and total and dissolved ortho-phosphate analyses of samples **11-CCA**, **11-CFS**, and **11-CPSF**. The nitrate/nitrite and total and dissolved ortho-phosphate data for these samples should be considered estimated (J). It should be noted that these samples were received with insufficient time to perform the analyses within holding times.

Blanks

The blanks with target analyte contamination are listed in the following table.

Blank	Contaminant	Concentration
11-43-F (Field Blank)	Total Dissolved Solids	230 mg/L
	Dissolved Kjeldahl Nitrogen	0.10 mg/L
11-44-S (Field Blank)	Total Suspended Solids	2.0 mg/L
	Total Kjeldahl Nitrogen	0.13 mg/L
	Dissolved Kjeldahl Nitrogen	0.14 mg/L
11-44-F (Equipment Blank)	Total Kjeldahl Nitrogen	0.12 mg/L
	Dissolved Kjeldahl Nitrogen	0.12 mg/L
11-43-S (Bottle Blank)	Total Kjeldahl Nitrogen	0.13 mg/L

A sample result was qualified as anomalous (U) if instrument concentration of the sample was within five-times the instrument concentration of an associated blank. The qualified data are summarized in the following table.

Analyte	Qualifier	Samples Qualified	Concentration
Total Kjeldahl Nitrogen	U	**11-31-F**	0.34 mg/L
		11-32-F	0.47 mg/L
		11-33-F	0.42 mg/L
		11-34-F	0.22 mg/L
		11-34-S	0.14 mg/L
		11-35-F	0.55 mg/L
		11-36-F	0.31 mg/L
		11-36-S	0.56 mg/L
		11-38-F	0.18 mg/L
		11-38-S	0.54 mg/L
		11-39-F	0.20 mg/L
		11-41-F	0.24 mg/L
		11-CCA	0.16 mg/L
		11-CFS	0.11 mg/L
		11-CPFS	0.20 mg/L
		11-PA	0.17 mg/L
		11-PCA	0.22 mg/L
		11-PFF	0.21 mg/L
Total Suspended Solids	**U**	**11-30-S**	6 mg/L
		11-40-F	6 mg/L
		11-42-S	4 mg/L
		11-CCA	2 mg/L
Total Suspended Solids (cont.)	**U**	**11-PA**	4 mg/L
		11-PCA	2 mg/L
		11-PFF	4 mg/L

Analyte	Qualifier	Samples Qualified	Concentration
Total Dissolved Solids	**U**	**11-30-S**	710 mg/L
		11-31-F	790 mg/L
		11-32-F	766 mg/L
		11-33-F	796 mg/L
		11-33-S	788 mg/L
		11-34-F	734 mg/L
		11-34-S	802 mg/L
		11-35-F	704 mg/L
		11-35-S	768 mg/L
		11-36-F	808 mg/L
		11-36-S	764 mg/L
		11-37-F	800 mg/L
		11-38-F	842 mg/L
		11-38-S	828 mg/L
		11-39-F	750 mg/L
		11-40-F	392 mg/L
		11-41-F	708 mg/L
		11-41-S	784 mg/L
		11-42-S	694 mg/L
		11-CCA	712 mg/L
		11-CFS	714 mg/L
		11-CPFS	720 mg/L
		11-I-01	784 mg/L
		11-I-03	776 mg/L
		11-PA	728 mg/L
		11-PCA	718 mg/L
		11-PFF	714 mg/L
Dissolved Kjeldahl Nitrogen	U	**11-30-S**	0.14 mg/L
		11-31-F	0.13 mg/L
		11-32-F	0.14 mg/L
		11-33-F	0.19 mg/L
		11-33-S	0.50 mg/L
		11-34-F	0.25 mg/L
		11-34-S	0.18 mg/L
		11-35-F	0.21 mg/L
		11-35-S	0.12 mg/L
		11-36-F	0.17 mg/L
		11-37-F	0.20 mg/L
		11-38-F	0.12 mg/L
		11-39-F	0.16 mg/L
		11-40-F	0.11 mg/L
		11-41-F	0.22 mg/L
		11-41-S	0.15 mg/L
		11-42-S	0.16 mg/L
		11-CCA	0.13 mg/L
		11-CFS	0.15 mg/L
		11-PA	0.21 mg/L
		11-PCA	0.24 mg/L
		11-PFF	0.22 mg/L

Laboratory Control Samples

The LCS recoveries for all analytes were within acceptance limits.

Matrix Spike and Matrix Spike Duplicate

The following table lists the project samples utilized for the Matrix Spike/Matrix Spike Duplicate analyses. The recoveries and relative percent differences were within the acceptance criteria.

Analyte	Project Sample(s) Utilized
Dissolved and Total Iron, Dissolved and Total Kjeldahl Nitrogen, Total Organic Carbon, Nitrate, Nitrite, Dissolved and Total Ortho-Phosphate, and Dissolved and Total Phosphorus	**11-32-F, 11-PA,** and **11-36-S**
Acid Soluble, Dissolved, and Total Aluminum	**11-32-F** and **11-36-S**

It should be noted that a low average percent recovery (68%) was reported for the total iron matrix spike analysis of sample **11-36-S**. Consequently, the reported results for total iron in samples **11-30-S, 11-31-F**, **11-36-F**, **11-36-S**, **11-37-F**, **11-38-S**, **11-38-F**, **11-39-F**, **11-40-F**, **11-42-S**, **11-CCA**, **11-CSF**, **11-CPSF**, **11-PCA**, and **11-PFF** should be considered estimated and may be biased low.

Laboratory Duplicates
The following table lists the project samples utilized for the Laboratory Duplicate analyses.

Analyte	Project Sample(s) Utilized
Total Alkalinity, Dissolved and Total Iron, Dissolved and Total Kjeldahl Nitrogen, Oil and Grease, Total Organic Carbon, Nitrate, Nitrite, Dissolved and Total Ortho-Phosphate, and Dissolved and Total Phosphorus	**11-32-F, 11-PA,** and **11-36-S**
Acid Soluble, Dissolved, and Total Aluminum, Total Dissolved Solids and Total Suspended Solids	**11-32-F** and **11-36-S**

The relative percent differences for all analytes were within the acceptance criteria except for total kjeldahl nitrogen in the laboratory duplicate analysis of sample **11-32-F**. Due to a high relative percent difference (38%) in the laboratory duplicate analyses, the total kjeldahl nitrogen data for the samples **11-32-F**, **11-33-F**, **11-33-S**, **11-34-F**, **11-34-S**, **11-35-F**, **11-35-S**, and **11-41-S** should be considered estimated (J).

Field Duplicates
The field duplicate pairs, **11-PFF/11-41-F**, **11-30-S/11-42-S**, and **11-I-01/11-41-S,** demonstrated acceptable field and laboratory precision for all analytes.

11-PFF/11-41-F			
Analyte	**Primary Sample Result**	**Field Duplicate Result**	**Qualifier**
Total Suspended Solids	4 mg/L	ND (1 mg/L)	**J[1]**
11-I-01/11-41-S			
Analyte	**Primary Sample Result**	**Field Duplicate Result**	**Qualifier**
Total Organic Carbon	16 mg/L	9.5 mg/L	**J[1]**
Note: 1. The primary and duplicate results differ by more than 50%, therefore, the data were considered estimated (J).			

Total/Dissolved Comparison
For all samples, a comparison of the total and dissolved data demonstrated acceptable results for all analytes except those listed in the following table.

Sample	Analyte	Total Result	Dissolved Result	Qualifier
11-37-F	Aluminum	290 µg/L	330 µg/L	**J[1]**

Sample	Analyte	Total Result	Dissolved Result	Qualifier
Notes: 1. The dissolved concentration exceeded the acid soluble aluminum concentration by more than the reporting limit or 10%. The data were estimated (J).				

Analyte Quantification

The project-specific reporting limits were met for all analyses except for the total phosphorus analysis of sample **11-31-F**. The reporting limit for total phosphorus in sample **11-31-F** was 0.30 mg/L instead of 0.03 mg/L.

Table 1. Lake Tahoe Pilot Project Samples

Sample	Lab Sample Number	Date Sampled
Project Samples		
11-33-S	T-305028-01	05/21/2003
11-33-F	T-305028-02	05/21/2003
11-34-F	T-305028-03	05/21/2003
11-34-S	T-305028-04	05/21/2003
11-35-F	T-305028-05	05/20/2003
11-35-S	T-305028-06	05/20/2003
11-41-S (Field Duplicate of 11-I-01)	T-305028-07	05/20/2003
11-32-F	T-305028-08	05/21/2003
11-41-F (Field Duplicate of 11-PFF)	T-305028-09	05/21/2003
11-I-01	T-305028-14	05/20/2003
11-I-03	T-305028-15	05/21/2003
11-PA	T-305028-16	05/21/2003
11-PCA	T-305028-17	05/21/2003
11-PFF	T-305028-18	05/21/2003
11-30-S	T-305028-19	05/22/2003
11-31-F	T-305028-20	05/22/2003
11-36-F	T-305028-21	05/22/2003
11-36-S	T-305028-22	05/22/2003
11-37-F	T-305028-23	05/22/2003
11-38-F	T-305028-24	05/22/2003
11-38-S	T-305028-25	05/22/2003
11-39-F	T-305028-26	05/22/2003
11-40-F	T-305028-27	05/22/2003
11-42-S (Field Duplicate of 11-30-S)	T-305028-28	05/22/2003
11-CCA	T-305028-29	05/21/2003
11-CFS	T-305028-30	05/21/2003
11-CPFS	T-305028-31	05/21/2003
11-JA-1	T-305028-32	05/20/2003
Field Blanks		
11-43-F	T-305028-10	05/20/2003
11-44-S	T-305028-13	05/20/2003
Field Blank	T-305028-33	05/21/2003
Equipment Blank		
11-44-F	T-305028-12	05/20/2003
Bottle Blank		
11-43-S	T-305028-11	05/20/2003
Trip Blank		
Trip Blank	T-305028-34	05/13/2003

RUN 12

DATE: June 30, 2003 **SITE:** Caltrans: Lake Tahoe Pilot Project

SUBJECT: **Caltrans: Lake Tahoe Pilot Project – Run 12**
ToxScan Report No.: T-305040

A limited data review (including electronic validation by Caltrans Laboratory EDD Processing Tool) was performed by the Sacramento Project Chemistry Group on ToxScan Report No.: T-3035040 in support of the Caltrans: Lake Tahoe Pilot Project. The report contains analytical data for 35 aqueous samples (including three field duplicate pairs, one performance evaluation sample, two field blanks, one bottle blank, one equipment blank, and one performance evaluation blank). Sample IDs are listed in Table 1. Samples **12-PA/12-41-F**, **12-38-S/12-42-S**, and **12-I-01/12-41-S** represent field duplicate pairs. The samples were collected between May 27 and 29, 2003 and submitted to ToxScan, Inc. in Watsonville, California for analysis of Nitrate (EPA Method 300.0), Nitrite (EPA Method 300.0), Oil and Grease (EPA Method 1664), Total Alkalinity (EPA Method 310.1), Total and Dissolved Aluminum (EPA Method 200.8), Acid Soluble Aluminum (EPA Method 440/5-86-008), Total Ammonia (SM-4500), Total and Dissolved Iron (EPA Method 200.7), Total and Dissolved Ortho-Phosphate (EPA Method 365.2), Total and Dissolved Kjeldahl Nitrogen (EPA Method 351.3), Total Organic Carbon (EPA Method 415.1), Total and Dissolved Phosphorous (EPA Method 365.2), Total Dissolved Solids (TDS; EPA Method 160.1), and Total Suspended Solids (TSS; EPA Method 160.2).

The data were reviewed in accordance with analytical methods outlined in EPA SW-846 and Analysis of Water and Wastewater. The following presents an overview of the limited data validation. The areas reviewed are listed below. A check mark (✓) indicates an area of review in which all data were acceptable without qualification; a crossed circle (⊗) signifies areas where issues raised during validation impacted data quality and/or usability.

- ✓ Data Completeness
- ✓ Holding Times
- ⊗ Blanks
- ✓ Laboratory Control Samples
- ⊗ Matrix Spike/Matrix Spike Duplicates
- ⊗ Laboratory Duplicates
- ⊗ Field Duplicates
- ⊗ Total/Dissolved Comparison
- ✓ Analyte Quantification

Data Completeness

The sample analyses were performed as requested on the chain-of-custody records with the exceptions summarized in the following table.

Analyte	Analysis Requested	Analysis Performed
Total Kjeldahl Nitrogen	EPA Method 351.3	EPA Method 351.1
Dissolved Kjeldahl Nitrogen	EPA Method 351.3	EPA Method 351.1

Holding Time and Preservation

The samples were analyzed within the holding times specified in the Caltrans: Guidance Manual: Storm Water Monitoring Protocols.

Blanks

The blanks with target analyte contamination are listed in the following table.

Blank	Contaminant	Concentration
12-43-S (Bottle Blank)	Total Alkalinity	2.0 mg/L
12-43-F (Field Blank)	Total Alkalinity	2.1 mg/L
	Dissolved Kjeldahl Nitrogen	0.18 mg/L
12-44-S (Field Blank)	Total Alkalinity	2.1 mg/L
	Total Kjeldahl Nitrogen	0.11 mg/L
12-44-F (Equipment Blank)	Total Alkalinity	3.0 mg/L
	Dissolved Kjeldahl Nitrogen	0.12 mg/L

A sample result was qualified as anomalous (U) if instrument concentration of the sample was within five-times the instrument concentration of an associated blank. The qualified data are summarized in the following table.

Analyte	Qualifier	Samples Qualified	Concentration
Total Alkalinity	U	**12-PCA**	13 mg/L
Dissolved Kjeldahl Nitrogen	U	**12-30-S**	0.27 mg/L
		12-31-F	0.44 mg/L
		12-32-F	0.27 mg/L
		12-33-F	0.20 mg/L
		12-33-S	0.21 mg/L
		12-34-F	0.29 mg/L
		12-34-S	0.24 mg/L
		12-35-F	0.35 mg/L
		12-35-S	0.23 mg/L
		12-36-F	0.25 mg/L
		12-36-S	0.28 mg/L
		12-37-F	0.37 mg/L
		12-38-F	0.37 mg/L
		12-38-S	0.25 mg/L
		12-39-F	0.35 mg/L
		12-40-F	0.39 mg/L
		12-41-F	0.38 mg/L
		12-42-S	0.42 mg/L
		12-CCA	0.28 mg/L
		12-CFS	0.27 mg/L
		12-CPFS	0.28 mg/L
		12-I-01	0.19 mg/L
		12-I-03	0.26 mg/L
		12-PA	0.45 mg/L
		12-PCA	0.29 mg/L
		12-PFF	0.37 mg/L
Total Kjeldahl Nitrogen	U	**12-30-S**	0.21 mg/L
		12-34-F	0.21 mg/L
		12-34-S	0.23 mg/L
		12-37-F	0.18 mg/L
		12-39-F	0.55 mg/L

Analyte	Qualifier	Samples Qualified	Concentration
		12-40-F	0.19 mg/L
		12-41-F	0.18 mg/L
		12-CCA	0.10 mg/L
		12-CFS	0.20 mg/L
		12-CPFS	0.20 mg/L
		12-PA	0.27 mg/L
		12-PCA	0.18 mg/L
		12-PFF	0.20 mg/L

Laboratory Control Samples
The LCS recoveries for all analytes were within acceptance limits.

Matrix Spike and Matrix Spike Duplicate
The following table lists the project samples utilized for the Matrix Spike/Matrix Spike Duplicate analyses.

Analyte	Project Sample(s) Utilized
Acid Soluble, Dissolved, and Total Aluminum, Dissolved and Total Iron, Dissolved and Total Kjeldahl Nitrogen, Total Organic Carbon, Nitrate, Nitrite, Dissolved and Total Ortho-Phosphate, and Dissolved and Total Phosphorus	**12-34-S, 12-33-F,** and **12-36-S**

The recoveries and relative percent differences were within the acceptance criteria for all analytes except total aluminum. Due to a high average percent recovery for aluminum (214%) in the matrix spike analyses, the results for total aluminum should be considered estimated (J) in the following samples.

Analyte	Project Sample with Estimated Results
Total Aluminum	**12-30-S, 12-31-F, 12-32-F, 12-33-F, 12-33-S, 12-34-F, 12-34-S, 12-35-F, 12-35-S, 12-36-F, 12-36-S, 12-37-F, 12-38-F, 12-38-S, 12-40-F, 12-41-F, 12-41-S, 12-42-S, 12-CCA, 12-CFS, 12-CPFS, 12-I-01, 12-I-03, 12-PA, 12-PCA,** and **12-PFF**

Laboratory Duplicates
The following table lists the project samples utilized for the Laboratory Duplicate analyses.

Analyte	Project Sample(s) Utilized
Total Alkalinity, Acid Soluble, Dissolved, and Total Aluminum, Dissolved and Total Iron, Dissolved and Total Kjeldahl Nitrogen, Oil and Grease, Total Organic Carbon, Nitrate, Nitrite, Dissolved and Total Ortho-Phosphate, Dissolved and Total Phosphorus, Total Dissolved Solids, and Total Suspended Solids	**12-34-S, 12-33-F,** and **12-36-S**

The relative percent differences for all analytes were within the acceptance criteria except for dissolved kjeldahl nitrogen in the laboratory duplicate analysis of sample **12-34-S**. Due to a high relative percent difference (38%) in the laboratory duplicate analyses, the dissolved kjeldahl nitrogen data for the samples **12-34-S**, **12-41-S**, **12-CCA**, **12-CFS, 12-CPFS,** and **12-I-01** should be considered estimated (J).

Field Duplicates

The field duplicate pairs, **12-A/12-41-F**, **12-38-S/12-42-S**, and **12-I-01/12-41-S**, demonstrated acceptable field and laboratory precision for all analytes except those listed below.

12-PA/12-41-F			
Analyte	**Primary Sample Result**	**Field Duplicate Result**	**Qualifier**
Dissolved Aluminum	94 µg/L	51 µg/L	**J[1]**
12-38-S/12-42-S			
Analyte	**Primary Sample Result**	**Field Duplicate Result**	**Qualifier**
Nitrate	0.42 mg/L	ND (0.10 mg/L)	**R[2]**
Dissolved Kjeldahl Nitrogen	0.25 mg/L	0.42 mg/L	**J[1]**
Total Organic Carbon	29 mg/L	ND (1.0 mg/L)	**R[2]**

Note:
1. The primary and duplicate results differ by more than 50%, therefore, the data were considered estimated (J).
2. The primary and duplicate results differ by more than 100%, therefore, the data were rejected (R).

Total/Dissolved Comparison

For all samples, a comparison of the total and dissolved data demonstrated acceptable results for all analytes except those listed in the following table.

Sample	**Analyte**	**Total Result**	**Dissolved Result**	**Qualifier**
12-31-F	Aluminum	340 µg/L	970 µg/L	**R[1]**
12-PA	Aluminum	47 µg/L	94 µg/L	**J[2]**
	Kjeldahl Nitrogen	0.27 mg/L	0.45 mg/L	**J[3]**
12-CCA	Aluminum	30 µg/L	62 µg/L	**J[2]**
	Kjeldahl Nitrogen	0.10 mg/L	0.28 mg/L	**J[3]**
12-40-F	Kjeldahl Nitrogen	0.19 mg/L	0.39 mg/L	**J[3]**
12-37-F	Kjeldahl Nitrogen	0.18 mg/L	0.37 mg/L	**J[3]**
12-PFF	Aluminum	82 µg/L	190 µg/L	**R[4]**
	Kjeldahl Nitrogen	0.20 mg/L	0.37 mg/L	**J[3]**
12-PCA	Kjeldahl Nitrogen	0.18 mg/L	0.29 mg/L	**J[3]**
12-41-F	Kjeldahl Nitrogen	0.27 mg/L	0.45 mg/L	**J[3]**

Notes:
1. The dissolved concentration exceeded the acid soluble aluminum concentration by more than 2-times the reporting limit or 20%. The data were rejected.
2. The dissolved concentration exceeded the acid soluble aluminum concentration by more than the reporting limit or 10%. The data were estimated (J).
3. The dissolved concentration exceeded the total concentration by more than the reporting limit or 10%. The data were estimated (J).
4. The acid soluble aluminum concentration exceeded the total aluminum concentration by more than 2-times the reporting limit or 20%. The data were rejected.

Analyte Quantification

The project-specific reporting limits were met for all analyses except for the oil and grease analysis of sample **12-CPSF**. The reporting limit for oil and grease in sample **12-CPSF** was 5 mg/L instead of 2 mg/L because one of the two sample aliquots was received broken.

Table 1. Lake Tahoe Pilot Project Samples

Sample	Lab Sample Number	Date Sampled
Project Samples		
12-CCA	T-305040-01	05/28/2003
12-CPFS	T-305040-02	05/28/2003
12-CFS	T-305040-03	05/28/2003
12-I-01	T-305040-07	05/27/2003
12-41-S (Field Duplicate of 12-I-01)	T-305040-08	05/27/2003
12-34-S	T-305040-10	05/28/2003
12-35-F	T-305040-11	05/27/2003
12-35-S	T-305040-12	05/27/2003
12-32-F	T-305040-13	05/28/2003
12-33-S	T-305040-14	05/28/2003
12-34-F	T-305040-15	05/28/2003
12-PA	T-305040-16	05/28/2003
12-33-F	T-305040-17	05/28/2003
12-41-F (Field Duplicate of 12-PA)	T-305040-18	05/28/2003
12-PCA	T-305040-19	05/28/2003
12-PFF	T-305040-20	05/28/2003
12-I-03	T-305040-21	05/28/2003
12-30-S	T-305040-22	05/29/2003
12-31-F	T-305040-23	05/29/2003
12-36-F	T-305040-24	05/29/2003
12-36-S	T-305040-25	05/29/2003
12-37-F	T-305040-26	05/29/2003
12-38-F	T-305040-27	05/29/2003
12-38-S	T-305040-28	05/29/2003
12-39-F	T-305040-29	05/29/2003
12-40-F	T-305040-30	05/29/2003
12-42-S (Field Duplicate of 12-38-S)	T-305040-31	05/29/2003
12-JA-1	T-305040-33	05/27/2003
12-JA-2	T-305040-34	05/27/2003
Field Blanks		
12-43-F	T-305040-05	05/27/2003
12-44-S	T-305040-06	05/27/2003
Field Blank	T-305040-34	05/13/2003
Equipment Blank		
12-44-F	T-305040-07	05/27/2003
Bottle Blank		
12-43-S	T-305040-04	05/28/2003
Laboratory Trip Blank		
Laboratory Trip Blank	T-305040-35	05/13/2003

ATTACHMENT A
DATA VALIDATION QUALIFIER DEFINITIONS AND INTERPRETATION KEY
Assigned by the URS Data Review Team

DATA QUALIFIER DEFINITIONS

U The analyte was analyzed for, but was not detected above the reported sample quantitation limit.

J The analyte was positively identified; the associated numerical value is the approximate concentration of the analyte in the sample.

N The analysis indicates the presence of an analyte for which there is presumptive evidence to make a "tentative identification."

NJ The analysis indicates the presence of an analyte that has been "tentatively identified" and the associated numerical value represents its approximate concentration.

UJ The analyte was not detected above the reported sample quantitation limit. However, the reported quantitation limit is approximate and may or may not represent the actual limit of quantitation necessary to accurately and precisely measure the analyte in the sample.

R The sample results are rejected due to serious deficiencies in the ability to analyze the sample and meet quality control criteria. The presence or absence of the analyte cannot be verified.

DATA QUALIFIER REASON CODE DEFINITIONS

a Analytical sequence deficiency or omission.
b Gross compound breakdown (4,4'-DDT/Endrin).
c Calibration failure; poor or unstable response.
d Laboratory duplicate imprecision.
e Laboratory duplicate control sample imprecision.
f Field duplicate imprecision.
g Poor chromatography.
h Holding time violation.
i Internal standard failure.
j Poor mass spectrographic performance.
k Serial dilution imprecision.
l Laboratory control sample recovery failure.
m Matrix spike/matrix spike duplicate recovery failure.
n Interference check sample recovery failure.
o Calibration blank contamination (metals/inorganics only).
p Preparation blank contamination (metals/inorganics only).
q Quantitation outside of linear range.
r Linearity failure in initial calibration.
s Surrogate spike recovery failure (GC organics and GC/MS organics only).
t Instrument tuning failure.
u No confirmation column present (GC Organics only).
v Value is estimated below the MDA (Rads only).
w Retention time (RT) outside of RT window.
x Field or equipment blank contamination.
y Trip blank contamination.
z Method blank contamination.
D Value exceeds quantitation limit.
Q Dissolved concentration significantly exceeded the total concentration.

Appendix E

Chemicals Used - Data Sheets

Appendix E Chemicals Used - Data Sheets

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PASS® C

EMERGENCY NUMBERS

IN CASE OF EMERGENCIES SUCH AS PRODUCT SPILLS, CALL:

CHEMTREC (800) 424-9300 USA (TOLL FREE)
CANUTEC (613) 996-6666 CANADA (CALL COLLECT)

1. CHEMICAL PRODUCT AND COMPANY IDENTIFICATION

	USA	CANADA
Supplier:	Eaglebrook, Inc. 4801 Southwick Dr. Suite 200 Matteson, IL 60443	Eaglebrook, Inc. of Canada / L'Environment Eaglebrook Québec 3405 Blvd. Marie Victorin Varennes, Québec J3X 1T6
Telephone:	(708) 747-5038 (800) 428-3311	(450) 652-0665 (800) 465-6171

Product Name: Aluminum Hydroxide Chloride Solution
Synonym: Aluminum Hydroxide Chloride Solution; Polyaluminum Chloride
Product Use: Drinking Water Treatment

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2. HAZARDOUS MATERIAL

Ingestion at high concentration causes serious problems to digestive system. If a spill occurs, there is a surface water contamination hazard.

Component	Concentration	CAS Number
Polyaluminum Chloride	25% – 40%	1327-41-9

3. HAZARDS IDENTIFICATION

Principal Risk: WHMIS – Class E. Irritating to skin, eyes and mucous membranes.

Potential Effects on Health: May cause an irritation.

Carcinogenicity: Does not contain any carcinogens or potential carcinogens.

4. FIRST AID MEASURES

First Aid: In every case of overexposure ask for medical attention. Move victim to fresh air.

Skin Contact: Wash with soap and water. Remove any contaminated clothing and wash before reuse. If an irritation develops, get medical attention.

Eye Contact: Flush eyes thoroughly with water for at least 15 minutes, taking care to keep the eyelids opened to be sure that the rinsing is complete. Get medical attention.

Inhalation: Move to fresh air. Give artificial respiration if breathing has stopped. If breathing is difficult, give oxygen. Get medical attention.

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Ingestion: Do not use mouth-to-mouth method if victim ingested or inhaled the substance; induce artificial respiration with the aid of a pocket mask equipped with a one way valve, or other proper respiratory medical device. Get medical attention.

5. FIRE FIGHTING MEASURES

Flash Point:	N/A
Flammable Limits:	N/A
Autoignition:	N/A
Hazardous Combustion Product:	N/A
Fire Fighting Instructions:	N/A
Fire and Explosion Hazards:	Non combustible

6. PREVENTION MEASURES

Wear appropriate personal protective equipment. Contain and eliminate the release. Neutralize with lime, limestone, or soda ash. This will generate carbon dioxide, so additional ventilation may be necessary. Collect the residues for proper disposal. Notify the appropriate environmental authorities.

Spill, Leak, Accidental

Neutralize with an alkaline solution (lime-water, sodium carbonate, sodium bicarbonate or sodium hydroxide). Liquid remaining after neutralization may be flushed to a sanitary sewer, if authorised. Recycle if possible. WARNING: Spills make floors slippery. Will give a strong astringent taste to water supply. High concentration may increase lead content of water if lead supply pipes are used.

Handling and Storage

Handle in containers, piping and pumps made of stainless steel, fiberglass or plastic. Avoid prolonged or repeated skin contact.

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Exposure Controls and Personal Protection

Ventilation:	There should be enough local ventilation to keep the TLV below the ACGIH limits.
Gloves:	Use neoprene or equivalent. Never use leather.
Eyes:	Wear chemical goggles or a face shield.
Respirator:	Use an approved dust and mist respirator with acid mist if necessary.
Clothing:	Protective clothing if necessary, should be neoprene or equivalent.

When cleaning, decontaminating or performing maintenance on tanks, containers, piping systems and accessories, and in any other situations where airborne contaminants and/or dust could be generated, use protective equipment to protect against ingestion or inhalation. HEPA or air supplied respirator, full Tyvek coveralls with head cover, gloves and boots or chemical suits, are suggested.

7. PHYSICAL AND CHEMICAL PROPERTIES

Boiling Point:	Decomposes at 90° C
Specific Gravity:	1.20 – 1.26
Vapor Pressure (mm Hg):	N/A
Percent Volatile By Vol.:	N/A
Vapor Density (Air=1):	N/A
Form:	Clear Liquid
Appearance:	Colorless to faint yellow
Odor:	Odorless
Solubility (water):	Hydrolyses

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pH Solution:	2.2 – 2.8
Flash Point:	N/A
Flammability:	N/A
Freezing Point:	<0° C

8. STABILITY AND REACTIVITY

Stability:	Stable
Hazardous Polymerization:	Does not occur.
Hazardous Decomposition:	May liberate sulphur oxides and aluminum oxides when boiled to dryness or heated above 200° C. May liberate chlorine.
Conditions to Avoid:	Contact with strong mineral acids, excessive heat, bases or alkalies, and hydro-reactive materials (i.e. Oleum).
Incompatible Materials:	Moderately acidic and slowly corrodes steel. Do not store in containers made of aluminum, magnesium, zinc, or copper alloys.

9. TOXICOLOGICAL INFORMATION

*No data available.

10. ECOLOGICAL INFORMATION

*No data available.

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14. OTHER INFORMATION

NFPA RATING

Health:	1
Flammability:	0
Reactivity:	1
Special Hazards:	CORROSIVE

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15. **ABBREVIATIONS**

ACGIH:	American Conference of Government Industrial Hygienists
AWWA:	American Water Works Association
CAS:	Chemical Abstracts Service
CIRC:	Cancer International Research Center
DOT:	Department of Transport
FRP:	Fiberglass Reinforced Plastic
HEPA:	High Efficiency Particulate Arresting
LEL:	Lower Explosive Limit
LD_{50}:	Lethal Dose
N/A:	Not Applicable
NFPA:	National Fire Protection Agency
NIOSH:	National Institute for Occupational Safety and Health
NSF:	National Sanitation Foundation
RCRA:	Resource Conservation and Recovery Act
RTECS:	Registry of Toxic Effects of Substances
TDG:	Transport of Dangerous Goods
TLV:	Threshold Limit Value
TWA:	Time Weight Average
UEL:	Upper Explosive Limit
WHMIS:	Workplace Hazardous Material Information System

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